An input and output Excel file for a material supply assignment model

Annexes

MASTER THESIS

Universiteit Gent – Industrial Management

2011/ 2012

Sergi Fabregat Corominas

Supervisor: prof. dr. ir. H. Van Landeghem

Co-supervisor: dr. V. Limère

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Annex 1

Macros

1.1 Macro: “OBTAINCOMBINATIONS”

```
Sub OBTAINCOMBINATIONS()

On Error GoTo salir
Dim r As Integer
Dim v As Integer
Dim i As Integer
Dim j As Integer
Dim h As Integer
Dim f As Integer
Dim q As Integer

Range("ac17:au65000").ClearContents
Range("AC17").Select
```

```
q = InputBox("Introduce the number of results: ", "Number of results", 1000)

Application.ScreenUpdating = False
Volver:
h = 0
f = 16

If ActiveCell.Offset(-1, 0) = "" Then
Application.ScreenUpdating = True
Range("AC17").Select
Exit Sub
End If

v = ActiveCell.Offset(-1, 0)
r = ActiveCell.Offset(-2, 0)

Do
If h > q Then Exit Do
For i = 0 To v - 1

   For j = 1 To r
    f = f + 1
      Cells(f, ActiveCell.Column()) = i
      ActiveCell.Offset(1, 0).Select
      h = h + 1
   Next
Next
Loop

Cells(17, ActiveCell.Column + 1).Select
GoTo Volver

salir:

End Sub
```

1.2 Macro: “OBTAINRESULTS”

```
Sub OBTAINRESULTS()
Dim a As Long, b As Long, c As Long, d As Long

Range("x7:au65000").ClearContents
Range("B6").Select

Const cant_Columnas As Byte = 23

Application.ScreenUpdating = False
a = ActiveCell.Row: b = 1 + ActiveCell.Column
c = a: d = b + cant_Columnas - 1
Cells(c, d).Resize(, cant_Columnas) = WorksheetFunction.Transpose(Cells(a, b - 1).Resize(cant_Columnas))
c = 1 + c

Do
 Cells(c, d).Resize(, cant_Columnas) = WorksheetFunction.Transpose(Cells(a, b).Resize(cant_Columnas))
 a = a + cant_Columnas: c = 1 + c
Loop While Cells(a, b) <> ""

Application.ScreenUpdating = True
End Sub
```

Annex 2

Computational results

2.1 New picking technologies in the supermarket

TEMPLATE

LOWER VALUE	UPPER VALUE	STEP VALUE	units	# of results	# total results
OPERARI_COST_lower	OPERARI_COST_upper	OPERARI_COST_step			55
30	30	10	€/h	1	
OPERARI_COST_LOGISTIC_lower	OPERARI_COST_LOGISTIC_upper	OPERARI_COST_LOGISTIC_step			
30	30	1	€/h	1	
MAXIMUM_WEIGHT_lower	MAXIMUM_WEIGHT_upper	MAXIMUM_WEIGHT_step			
30	30	2	Kg	1	
MILK_RUN_TOUR_KIT_lower	MILK_RUN_TOUR_KIT_upper	MILK_RUN_TOUR_KIT_step			
1640	1640	100	m	1	
MILK_RUN_TOUR_BOX_lower	MILK_RUN_TOUR_BOX_upper	MILK_RUN_TOUR_BOX_step			
1640	1640	100	m	1	
SEARCH_TIME_KIT_lower	SEARCH_TIME_KIT_upper	SEARCH_TIME_KIT_step			
0,54	1,08	0,01	s	55	
SEARCH_TIME_BULK_lower	SEARCH_TIME_BULK_upper	SEARCH_TIME_BULK_step			
1,08	1,08	0,01	s	1	
BATCH_SIZE_lower	BATCH_SIZE_upper	BATCH_SIZE_step			
5	5	4	kit	1	
LENGTH_FACTOR_lower	LENGTH_FACTOR_upper	LENGTH_FACTOR_step			
1	1	0,1	-	1	
TRANSPORT_VELOCITY_BOX_lower	TRANSPORT_VELOCITY_BOX_upper	TRANSPORT_VELOCITY_BOX_step			
2412	2412	50	m/h	1	
TRANSPORT_VELOCITY_PALLET_lower	TRANSPORT_VELOCITY_PALLET_upper	TRANSPORT_VELOCITY_PALLET_step			
2880	2880	50	m/h	1	
TRANSPORT_VELOCITY_KIT_lower	TRANSPORT_VELOCITY_KIT_upper	TRANSPORT_VELOCITY_KIT_step			
2412	2412	50	m/h	1	
CAPACITY_MRT_BOX_lower	CAPACITY_MRT_BOX_upper	CAPACITY_MRT_BOX_step			
60	60	10	box	1	
CAPACITY_MRT_KIT_lower	CAPACITY_MRT_KIT_upper	CAPACITY_MRT_KIT_step			
70	70	10	kit	1	
CONSTANT_REPLENISH_BOX_lower	CONSTANT_REPLENISH_BOX_upper	CONSTANT_REPLENISH_BOX_step			
0,2	0,2	0,2	€	1	
CONSTANT_REPLENISH_PALLET_lower	CONSTANT_REPLENISH_PALLET_upper	CONSTANT_REPLENISH_PALLET_step			
1,2	1,2	0,6	€	1	
VOLUME_FACTOR_lower	VOLUME_FACTOR_upper	VOLUME_FACTOR_step			
1	1	0,1	-	1	
DISTANCE_PALLET_FACTOR_lower	DISTANCE_PALLET_FACTOR_upper	DISTANCE_PALLET_FACTOR_step			
1	1	0,3	-	1	
CONSTANT_REPLENISH_3PL_lower	CONSTANT_REPLENISH_3PL_upper	CONSTANT_REPLENISH_3PL_step			
0	0	0,1		1	

Parameter's values combinations

Obtain Combinations

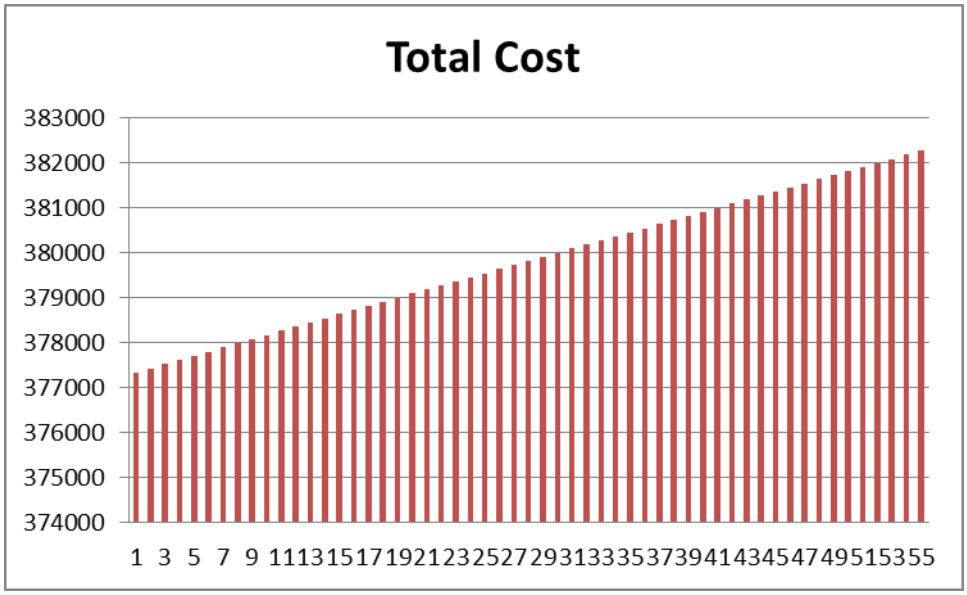
#	OC	OCL	w^k	D^k	D^b	τ^k	τ^{bulk}	B^k	L^{fact}	V^b	V^p	V^k	A^b	A^k	R^b	R^p	V^{fact}	Dp^{fact}	R^{3PL}
Number of result	Operari Cost	Operari Cost Logistic	Maximum weight	Milk Run Tour Kit	Milk Run Tour Box	Search Time Kit	Search Time Bulk	Batch Size	Length Factor	Transport Velocity Box	Transport Velocity Pallet	Transport Velocity Kit	Capacity MRT Box	Capacity MRT Kit	Constant Replenish Box	Constant Replenish Pallet	Volume Factor	Distance Pallet Factor	Constant Replenish 3PL
1	30	30	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
2	30	30	30	1640	1640	0,55	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
3	30	30	30	1640	1640	0,56	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
4	30	30	30	1640	1640	0,57	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
5	30	30	30	1640	1640	0,58	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
6	30	30	30	1640	1640	0,59	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
7	30	30	30	1640	1640	0,6	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
8	30	30	30	1640	1640	0,61	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
9	30	30	30	1640	1640	0,62	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
10	30	30	30	1640	1640	0,63	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
11	30	30	30	1640	1640	0,64	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
12	30	30	30	1640	1640	0,65	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
13	30	30	30	1640	1640	0,66	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
14	30	30	30	1640	1640	0,67	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
15	30	30	30	1640	1640	0,68	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
16	30	30	30	1640	1640	0,69	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
17	30	30	30	1640	1640	0,7	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
18	30	30	30	1640	1640	0,71	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
19	30	30	30	1640	1640	0,72	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
20	30	30	30	1640	1640	0,73	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
21	30	30	30	1640	1640	0,74	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
22	30	30	30	1640	1640	0,75	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
23	30	30	30	1640	1640	0,76	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
24	30	30	30	1640	1640	0,77	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
25	30	30	30	1640	1640	0,78	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
26	30	30	30	1640	1640	0,79	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
27	30	30	30	1640	1640	0,8	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
28	30	30	30	1640	1640	0,81	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
29	30	30	30	1640	1640	0,82	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
30	30	30	30	1640	1640	0,83	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
31	30	30	30	1640	1640	0,84	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
32	30	30	30	1640	1640	0,85	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
33	30	30	30	1640	1640	0,86	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
34	30	30	30	1640	1640	0,87	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
35	30	30	30	1640	1640	0,88	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
36	30	30	30	1640	1640	0,89	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
37	30	30	30	1640	1640	0,9	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
38	30	30	30	1640	1640	0,91	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
39	30	30	30	1640	1640	0,92	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
40	30	30	30	1640	1640	0,93	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
41	30	30	30	1640	1640	0,94	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
42	30	30	30	1640	1640	0,95	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
43	30	30	30	1640	1640	0,96	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
44	30	30	30	1640	1640	0,97	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
45	30	30	30	1640	1640	0,98	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0

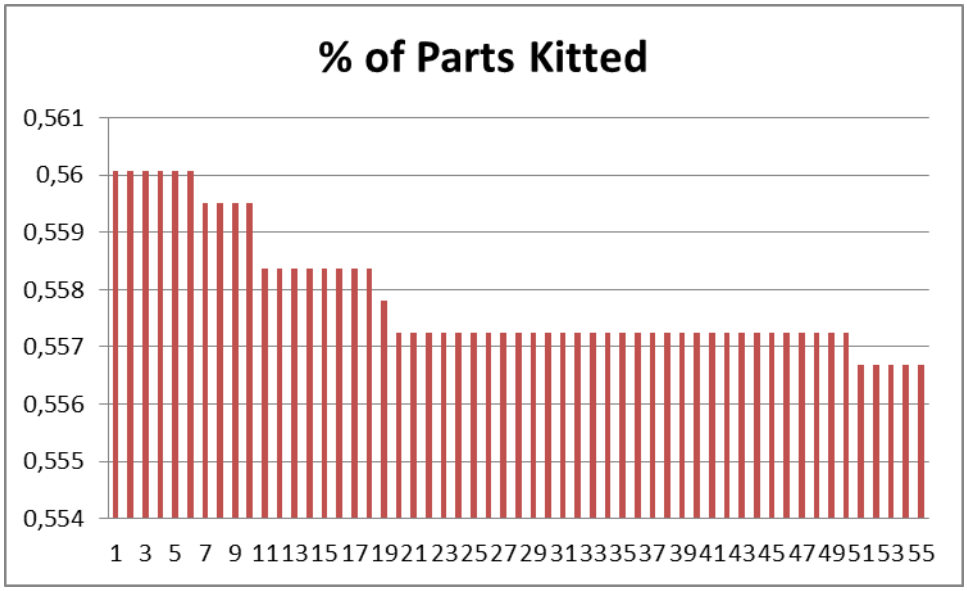
46	30	30	30	1640	1640	0,99	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
47	30	30	30	1640	1640	1	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
48	30	30	30	1640	1640	1,01	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
49	30	30	30	1640	1640	1,02	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
50	30	30	30	1640	1640	1,03	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
51	30	30	30	1640	1640	1,04	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
52	30	30	30	1640	1640	1,05	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
53	30	30	30	1640	1640	1,06	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
54	30	30	30	1640	1640	1,07	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
55	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0

TABLE OF RESULTS

Num.	Num of parts	Total Cost	Cost pick bulk	Cost pick kit	Cost transp pal	Cost transp box	Cost transp kit	Cost of kitting	Cost Repl Pal	Cost Repl box	Cost repl 3PL	Percentage of parts kitted	Number of parts bulked	Number of kits used
Num.	card(COMBI) =	Total_Cost =	Cost_pick_bulk =	Cost_pick_kit =	Cost_Transp_pal =	Cost_Transp_box =	Cost_Transp_kit =	Cost_Kitting =	Cost_Repl_pal =	Cost_Repl_box =	Cost_Repl_3pl =	(sum{(i,s) in COMBI} (1 - x[i,	sum{(i,s) in COMBI} x[i,s]	sum{s in S} K[s] =
1	1773	377333	101163	39729,4	58584,7	43490,9	70118,2	49269,5	6031,08	8946,38	0	0,560068	780	55
2	1773	377426	101163	39729,4	58584,7	43490,9	70118,2	49363,3	6031,08	8946,38	0	0,560068	780	55
3	1773	377520	101163	39729,4	58584,7	43490,9	70118,2	49457,2	6031,08	8946,38	0	0,560068	780	55
4	1773	377614	101163	39729,4	58584,7	43490,9	70118,2	49551	6031,08	8946,38	0	0,560068	780	55
5	1773	377708	101163	39729,4	58584,7	43490,9	70118,2	49644,8	6031,08	8946,38	0	0,560068	780	55
6	1773	377802	101163	39729,4	58584,7	43490,9	70118,2	49738,6	6031,08	8946,38	0	0,560068	780	55
7	1773	377896	101345	39620	58584,7	43610,6	70118,2	49675	6031,08	8911,15	0	0,559504	781	55
8	1773	377989	101345	39620	58584,7	43610,6	70118,2	49768,4	6031,08	8911,15	0	0,559504	781	55
9	1773	378082	101345	39620	58584,7	43610,6	70118,2	49861,8	6031,08	8911,15	0	0,559504	781	55
10	1773	378176	101345	39620	58584,7	43610,6	70118,2	49955,1	6031,08	8911,15	0	0,559504	781	55
11	1773	378269	102342	39020,6	58488,4	44133,2	70118,2	49321,3	6087,66	8757,44	0	0,558376	783	55
12	1773	378360	102342	39020,6	58488,4	44133,2	70118,2	49412,7	6087,66	8757,44	0	0,558376	783	55
13	1773	378451	102342	39020,6	58488,4	44133,2	70118,2	49504,1	6087,66	8757,44	0	0,558376	783	55
14	1773	378543	102342	39020,6	58488,4	44133,2	70118,2	49595,5	6087,66	8757,44	0	0,558376	783	55
15	1773	378634	102342	39020,6	58488,4	44133,2	70118,2	49686,9	6087,66	8757,44	0	0,558376	783	55
16	1773	378726	102342	39020,6	58488,4	44133,2	70118,2	49778,3	6087,66	8757,44	0	0,558376	783	55
17	1773	378817	102342	39020,6	58488,4	44133,2	70118,2	49869,6	6087,66	8757,44	0	0,558376	783	55
18	1773	378908	102342	39020,6	58488,4	44133,2	70118,2	49961	6087,66	8757,44	0	0,558376	783	55
19	1773	379000	102467	38933,1	58488,4	44157	70118,2	49998,2	6087,66	8750,44	0	0,557812	784	55
20	1773	379091	102721	38850	58569,4	43976,1	70118,2	49986,1	6066,66	8803,64	0	0,557248	785	55
21	1773	379182	102721	38850	58569,4	43976,1	70118,2	50077	6066,66	8803,64	0	0,557248	785	55
22	1773	379273	102721	38850	58569,4	43976,1	70118,2	50168	6066,66	8803,64	0	0,557248	785	55
23	1773	379364	102721	38850	58569,4	43976,1	70118,2	50259	6066,66	8803,64	0	0,557248	785	55
24	1773	379455	102721	38850	58569,4	43976,1	70118,2	50350	6066,66	8803,64	0	0,557248	785	55
25	1773	379546	102760	38819,4	58569,4	44010,2	70118,2	50407,8	6066,66	8793,63	0	0,557248	785	55
26	1773	379636	102760	38819,4	58569,4	44010,2	70118,2	50498,7	6066,66	8793,63	0	0,557248	785	55
27	1773	379727	102760	38819,4	58569,4	44010,2	70118,2	50589,6	6066,66	8793,63	0	0,557248	785	55
28	1773	379818	102760	38819,4	58569,4	44010,2	70118,2	50680,5	6066,66	8793,63	0	0,557248	785	55
29	1773	379909	102760	38819,4	58569,4	44010,2	70118,2	50771,4	6066,66	8793,63	0	0,557248	785	55
30	1773	380000	102760	38819,4	58569,4	44010,2	70118,2	50862,3	6066,66	8793,63	0	0,557248	785	55
31	1773	380091	102760	38819,4	58569,4	44010,2	70118,2	50953,1	6066,66	8793,63	0	0,557248	785	55
32	1773	380182	102760	38819,4	58569,4	44010,2	70118,2	51044	6066,66	8793,63	0	0,557248	785	55
33	1773	380273	102760	38819,4	58569,4	44010,2	70118,2	51134,9	6066,66	8793,63	0	0,557248	785	55
34	1773	380364	102760	38819,4	58569,4	44010,2	70118,2	51225,8	6066,66	8793,63	0	0,557248	785	55
35	1773	380454	102760	38819,4	58569,4	44010,2	70118,2	51316,7	6066,66	8793,63	0	0,557248	785	55
36	1773	380545	102760	38819,4	58569,4	44010,2	70118,2	51407,5	6066,66	8793,63	0	0,557248	785	55
37	1773	380636	102760	38819,4	58569,4	44010,2	70118,2	51498,4	6066,66	8793,63	0	0,557248	785	55
38	1773	380727	102760	38819,4	58569,4	44010,2	70118,2	51589,3	6066,66	8793,63	0	0,557248	785	55
39	1773	380818	102760	38819,4	58569,4	44010,2	70118,2	51680,2	6066,66	8793,63	0	0,557248	785	55
40	1773	380909	102760	38819,4	58569,4	44010,2	70118,2	51771,1	6066,66	8793,63	0	0,557248	785	55

41	1773	381000	102760	38819,4	58569,4	44010,2	70118,2	51862	6066,66	8793,63	0	0,557248	785	55
42	1773	381091	102760	38819,4	58569,4	44010,2	70118,2	51952,8	6066,66	8793,63	0	0,557248	785	55
43	1773	381181	102760	38819,4	58569,4	44010,2	70118,2	52043,7	6066,66	8793,63	0	0,557248	785	55
44	1773	381272	102760	38819,4	58569,4	44010,2	70118,2	52134,6	6066,66	8793,63	0	0,557248	785	55
45	1773	381363	102760	38819,4	58569,4	44010,2	70118,2	52225,5	6066,66	8793,63	0	0,557248	785	55
46	1773	381454	102760	38819,4	58569,4	44010,2	70118,2	52316,4	6066,66	8793,63	0	0,557248	785	55
47	1773	381545	102760	38819,4	58569,4	44010,2	70118,2	52407,2	6066,66	8793,63	0	0,557248	785	55
48	1773	381636	102760	38819,4	58569,4	44010,2	70118,2	52498,1	6066,66	8793,63	0	0,557248	785	55
49	1773	381727	102760	38819,4	58569,4	44010,2	70118,2	52589	6066,66	8793,63	0	0,557248	785	55
50	1773	381818	102760	38819,4	58569,4	44010,2	70118,2	52679,9	6066,66	8793,63	0	0,557248	785	55
51	1773	381908	102889	38753,7	58569,4	44045,8	70118,2	52682,4	6066,66	8783,13	0	0,556684	786	55
52	1773	381999	102889	38753,7	58569,4	44045,8	70118,2	52773,1	6066,66	8783,13	0	0,556684	786	55
53	1773	382090	102889	38753,7	58569,4	44045,8	70118,2	52863,7	6066,66	8783,13	0	0,556684	786	55
54	1773	382180	102889	38753,7	58569,4	44045,8	70118,2	52954,4	6066,66	8783,13	0	0,556684	786	55
55	1773	382271	102889	38753,7	58569,4	44045,8	70118,2	53045,1	6066,66	8783,13	0	0,556684	786	55


Total Cost
383000
382000
381000
380000
379000
378000
377000
376000
375000
374000
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55


% of Parts Kitted
0,561
0,56
0,559
0,558
0,557
0,556
0,555
0,554
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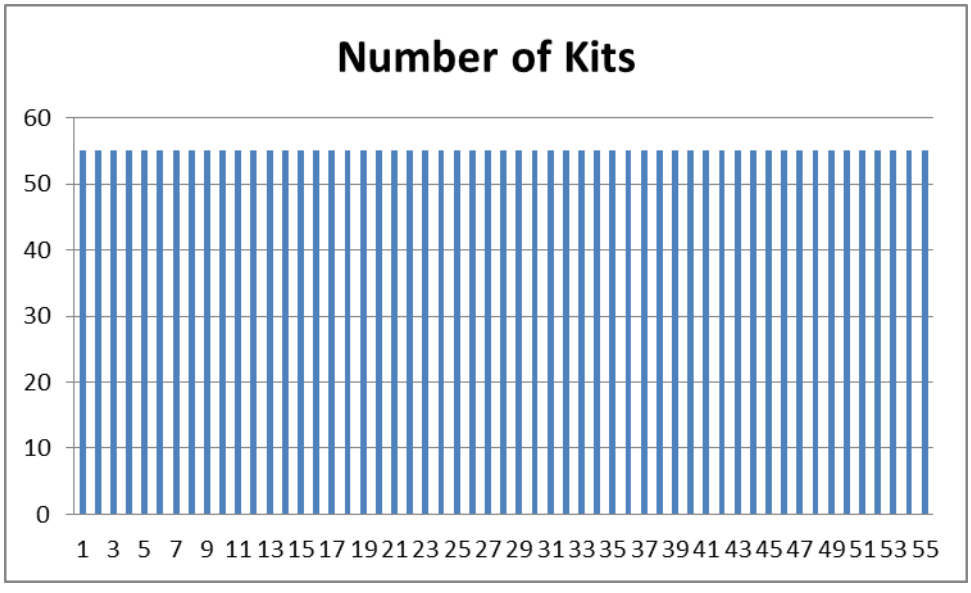
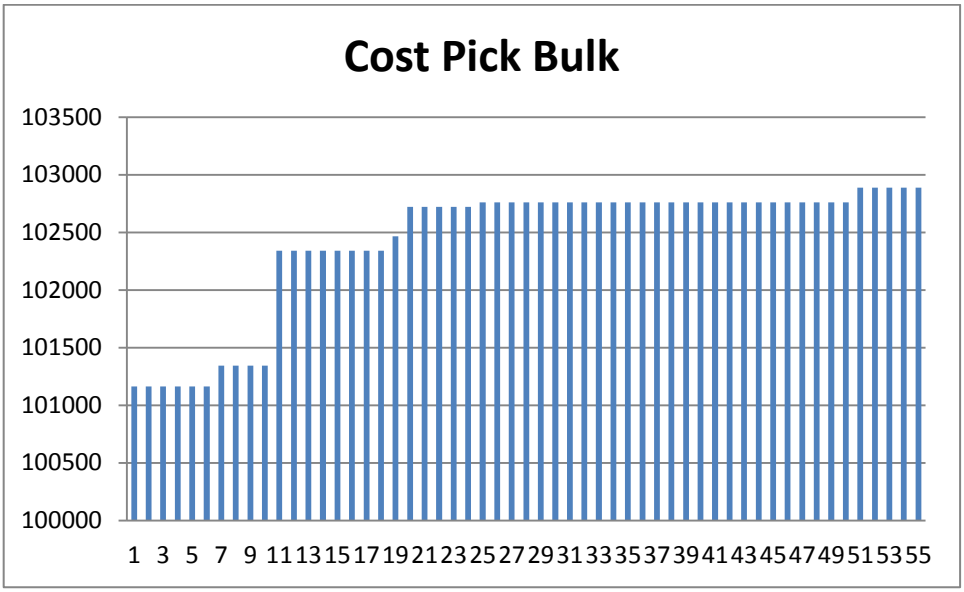
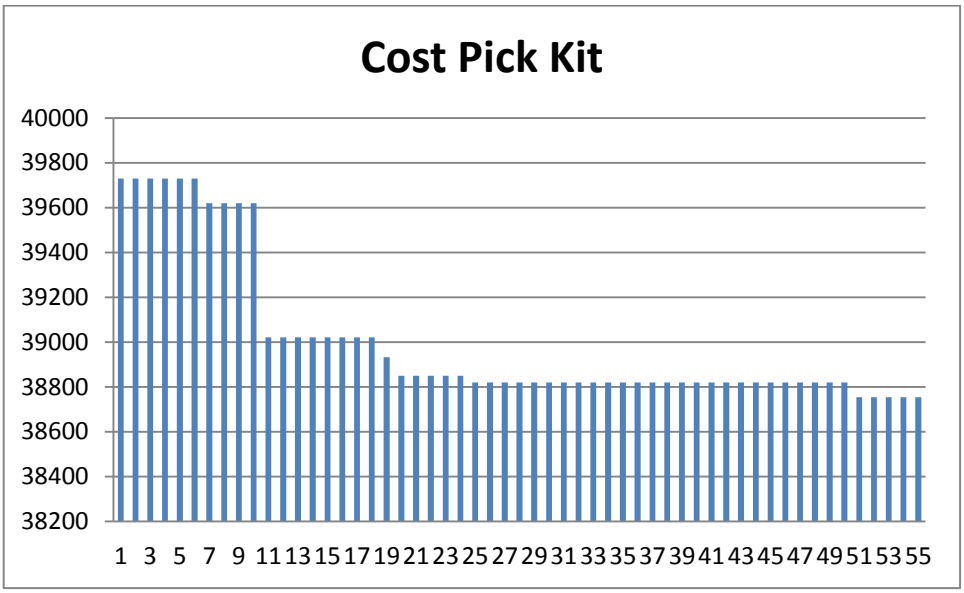
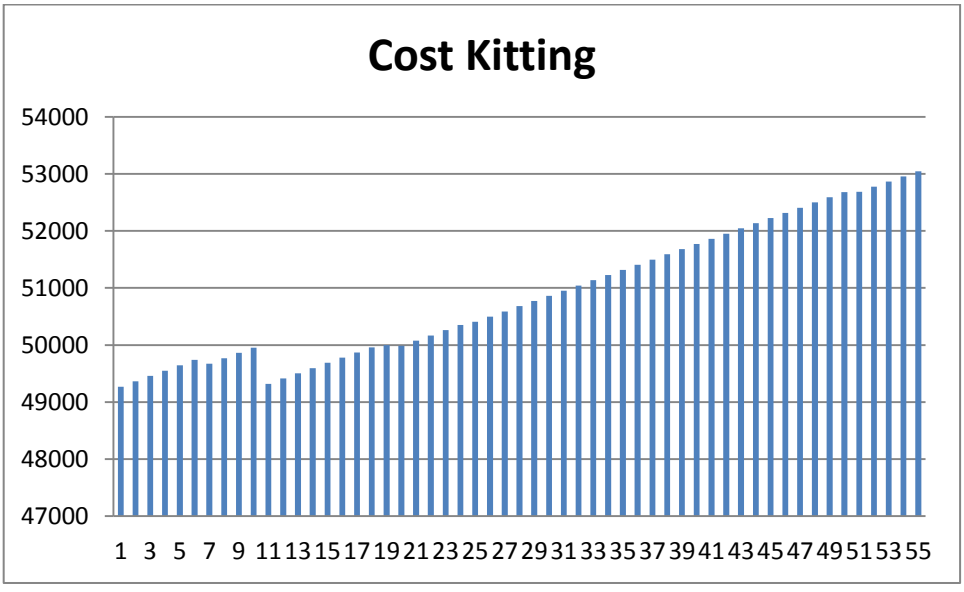
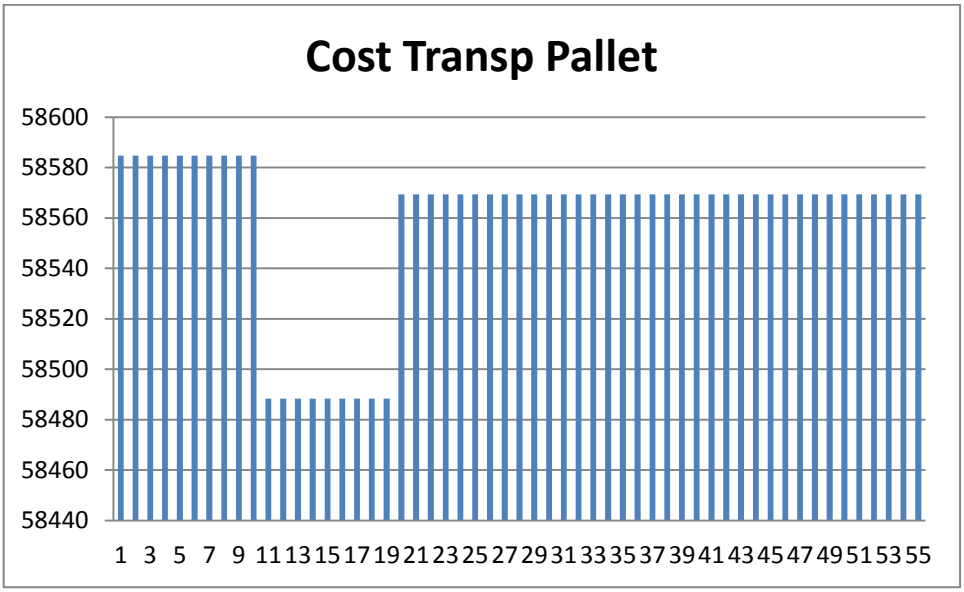
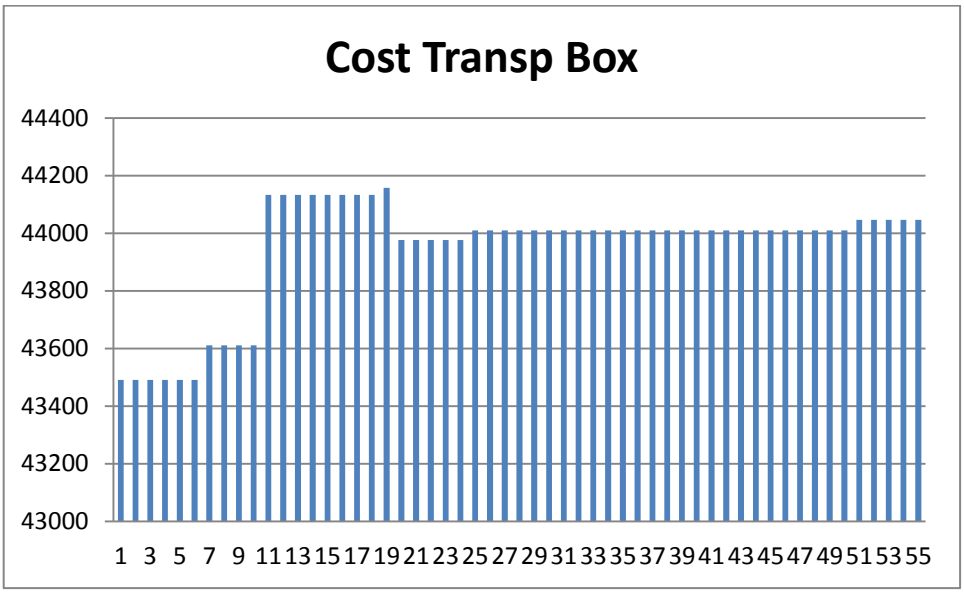

Number of Kits
60
50
40
30
20
10
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55

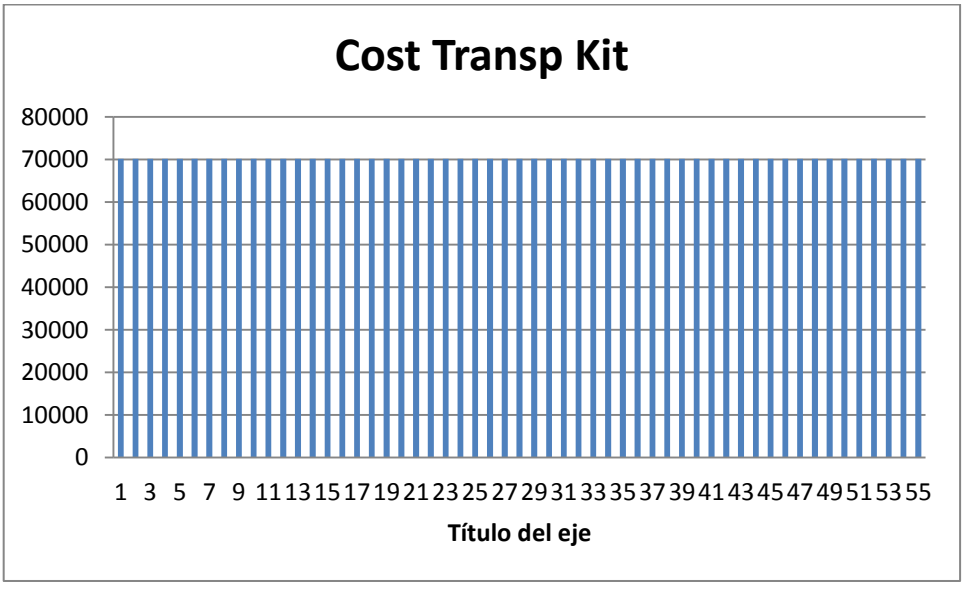

Cost Pick Bulk
103500
103000
102500
102000
101500
101000
100500
100000
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55

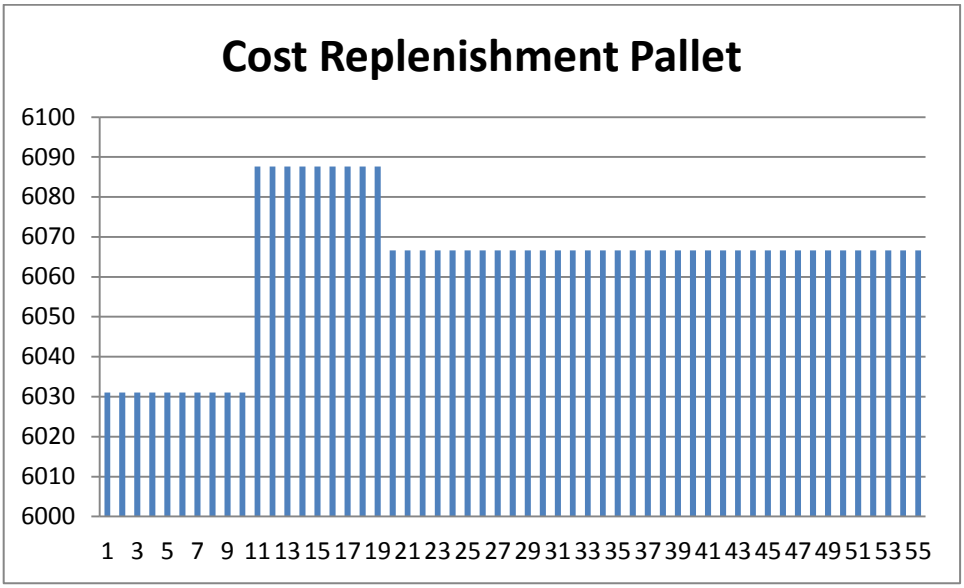

Cost Pick Kit
40000
39800
39600
39400
39200
39000
38800
38600
38400
38200
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55

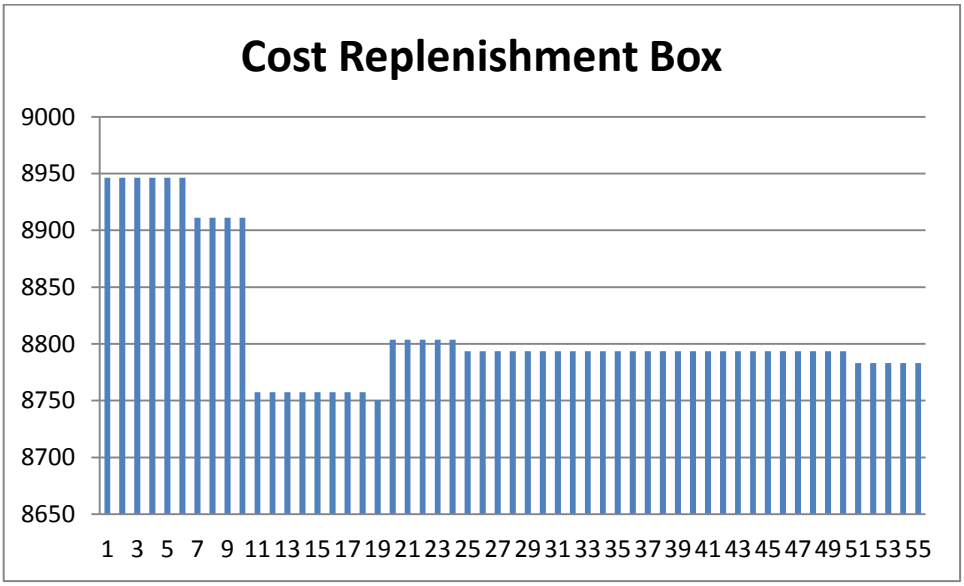

Cost Kitting
54000
53000
52000
51000
50000
49000
48000
47000
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55

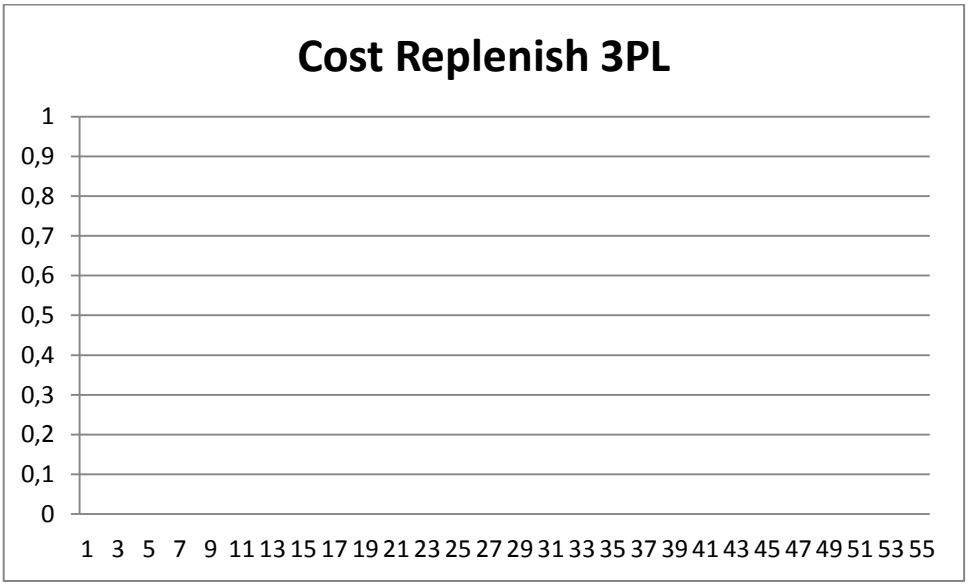

Cost Transp Pallet
58600
58580
58560
58540
58520
58500
58480
58460
58440
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55


Cost Transp Box
44400
44200
44000
43800
43600
43400
43200
43000
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55


Cost Transp Kit
80000
70000
60000
50000
40000
30000
20000
10000
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55
Título del eje


Cost Replenishment Pallet
6100
6090
6080
6070
6060
6050
6040
6030
6020
6010
6000
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55


Cost Replenishment Box
9000
8950
8900
8850
8800
8750
8700
8650
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55


Cost Replenish 3PL
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55

2.2 New picking technologies in the supermarket and in the assembly line

TEMPLATE

LOWER VALUE	UPPER VALUE	STEP VALUE	units	# of results	# total results
OPERARI_COST_lower	OPERARI_COST_upper	OPERARI_COST_step			55
30	30	10	€/h	1	
OPERARI_COST_LOGISTIC_lower	OPERARI_COST_LOGISTIC_upper	OPERARI_COST_LOGISTIC_step			
30	30	1	€/h	1	
MAXIMUM_WEIGHT_lower	MAXIMUM_WEIGHT_upper	MAXIMUM_WEIGHT_step			
30	30	2	Kg	1	
MILK_RUN_TOUR_KIT_lower	MILK_RUN_TOUR_KIT_upper	MILK_RUN_TOUR_KIT_step			
1640	1640	100	m	1	
MILK_RUN_TOUR_BOX_lower	MILK_RUN_TOUR_BOX_upper	MILK_RUN_TOUR_BOX_step			
1640	1640	100	m	1	
SEARCH_TIME_KIT_lower	SEARCH_TIME_KIT_upper	SEARCH_TIME_KIT_step			
0,54	0,54	0,01	s	1	
SEARCH_TIME_BULK_lower	SEARCH_TIME_BULK_upper	SEARCH_TIME_BULK_step			
0,54	1,08	0,01	s	55	
BATCH_SIZE_lower	BATCH_SIZE_upper	BATCH_SIZE_step			
5	5	4	kit	1	
LENGTH_FACTOR_lower	LENGTH_FACTOR_upper	LENGTH_FACTOR_step			
1	1	0,1	-	1	
TRANSPORT_VELOCITY_BOX_lower	TRANSPORT_VELOCITY_BOX_upper	TRANSPORT_VELOCITY_BOX_step			
2412	2412	50	m/h	1	
TRANSPORT_VELOCITY_PALLET_lower	TRANSPORT_VELOCITY_PALLET_upper	TRANSPORT_VELOCITY_PALLET_step			
2880	2880	50	m/h	1	
TRANSPORT_VELOCITY_KIT_lower	TRANSPORT_VELOCITY_KIT_upper	TRANSPORT_VELOCITY_KIT_step			
2412	2412	50	m/h	1	
CAPACITY_MRT_BOX_lower	CAPACITY_MRT_BOX_upper	CAPACITY_MRT_BOX_step			
60	60	10	box	1	
CAPACITY_MRT_KIT_lower	CAPACITY_MRT_KIT_upper	CAPACITY_MRT_KIT_step			
70	70	10	kit	1	
CONSTANT_REPLENISH_BOX_lower	CONSTANT_REPLENISH_BOX_upper	CONSTANT_REPLENISH_BOX_step			
0,2	0,2	0,2	€	1	
CONSTANT_REPLENISH_PALLET_lower	CONSTANT_REPLENISH_PALLET_upper	CONSTANT_REPLENISH_PALLET_step			
1,2	1,2	0,6	€	1	
VOLUME_FACTOR_lower	VOLUME_FACTOR_upper	VOLUME_FACTOR_step			
1	1	0,1	-	1	
DISTANCE_PALLET_FACTOR_lower	DISTANCE_PALLET_FACTOR_upper	DISTANCE_PALLET_FACTOR_step			
1	1	0,3	-	1	
CONSTANT_REPLENISH_3PL_lower	CONSTANT_REPLENISH_3PL_upper	CONSTANT_REPLENISH_3PL_step			
0	0	0,1		1	

Parameter's values combinations

Obtain Combinations

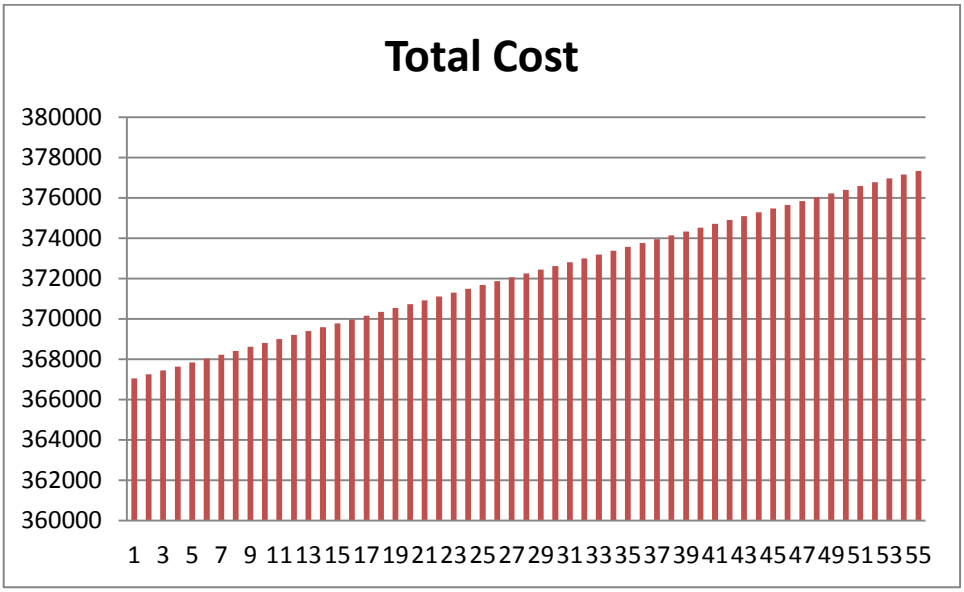
#	OC	OCL	w^k	D^k	D^b	τ^k	τ^{bulk}	B^k	L^{fact}	V^b	V^p	V^k	A^b	A^k	R^b	R^p	V^{fact}	Dp^{fact}	R^{3PL}
Number of result	Operari Cost	Operari Cost Logistic	Maximum weight	Milk Run Tour Kit	Milk Run Tour Box	Search Time Kit	Search Time Bulk	Batch Size	Length Factor	Transport Velocity Box	Transport Velocity Pallet	Transport Velocity Kit	Capacity MRT Box	Capacity MRT Kit	Constant Replenish Box	Constant Replenish Pallet	Volume Factor	Distance Pallet Factor	Constant Replenish 3PL
1	30	30	30	1640	1640	0,54	0,54	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
2	30	30	30	1640	1640	0,54	0,55	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
3	30	30	30	1640	1640	0,54	0,56	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
4	30	30	30	1640	1640	0,54	0,57	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
5	30	30	30	1640	1640	0,54	0,58	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
6	30	30	30	1640	1640	0,54	0,59	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
7	30	30	30	1640	1640	0,54	0,6	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
8	30	30	30	1640	1640	0,54	0,61	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
9	30	30	30	1640	1640	0,54	0,62	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
10	30	30	30	1640	1640	0,54	0,63	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
11	30	30	30	1640	1640	0,54	0,64	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
12	30	30	30	1640	1640	0,54	0,65	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
13	30	30	30	1640	1640	0,54	0,66	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
14	30	30	30	1640	1640	0,54	0,67	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
15	30	30	30	1640	1640	0,54	0,68	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
16	30	30	30	1640	1640	0,54	0,69	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
17	30	30	30	1640	1640	0,54	0,7	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
18	30	30	30	1640	1640	0,54	0,71	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
19	30	30	30	1640	1640	0,54	0,72	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
20	30	30	30	1640	1640	0,54	0,73	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
21	30	30	30	1640	1640	0,54	0,74	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
22	30	30	30	1640	1640	0,54	0,75	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
23	30	30	30	1640	1640	0,54	0,76	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
24	30	30	30	1640	1640	0,54	0,77	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
25	30	30	30	1640	1640	0,54	0,78	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
26	30	30	30	1640	1640	0,54	0,79	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
27	30	30	30	1640	1640	0,54	0,8	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
28	30	30	30	1640	1640	0,54	0,81	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
29	30	30	30	1640	1640	0,54	0,82	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
30	30	30	30	1640	1640	0,54	0,83	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
31	30	30	30	1640	1640	0,54	0,84	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
32	30	30	30	1640	1640	0,54	0,85	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
33	30	30	30	1640	1640	0,54	0,86	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
34	30	30	30	1640	1640	0,54	0,87	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
35	30	30	30	1640	1640	0,54	0,88	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
36	30	30	30	1640	1640	0,54	0,89	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
37	30	30	30	1640	1640	0,54	0,9	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
38	30	30	30	1640	1640	0,54	0,91	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
39	30	30	30	1640	1640	0,54	0,92	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
40	30	30	30	1640	1640	0,54	0,93	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
41	30	30	30	1640	1640	0,54	0,94	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
42	30	30	30	1640	1640	0,54	0,95	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
43	30	30	30	1640	1640	0,54	0,96	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
44	30	30	30	1640	1640	0,54	0,97	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
45	30	30	30	1640	1640	0,54	0,98	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0

46	30	30	30	1640	1640	0,54	0,99	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
47	30	30	30	1640	1640	0,54	1	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
48	30	30	30	1640	1640	0,54	1,01	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
49	30	30	30	1640	1640	0,54	1,02	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
50	30	30	30	1640	1640	0,54	1,03	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
51	30	30	30	1640	1640	0,54	1,04	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
52	30	30	30	1640	1640	0,54	1,05	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
53	30	30	30	1640	1640	0,54	1,06	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
54	30	30	30	1640	1640	0,54	1,07	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
55	30	30	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0

TABLE OF RESULTS

Num.	Num of parts	Total Cost	Cost pick bulk	Cost pick kit	Cost transp pal	Cost transp box	Cost transp kit	Cost of kitting	Cost Repl Pal	Cost Repl box	Cost repl 3PL	Percentage of parts kitted	Number of parts bulked	Number of kits used
Num.	card(COMBI) =	Total_Cost =	Cost_pick_bulk =	Cost_pick_kit =	Cost_Transp_pal =	Cost_Transp_box =	Cost_Transp_kit =	Cost_Kitting =	Cost_Repl_pal =	Cost_Repl_box =	Cost_Repl_3pl =	(sum{(i,s) in COMBI} (1 - x[i,	sum{(i,s) in COMBI} x[i,s]	sum{s in S} K[s] =
1	1773	367049	95749,1	37117,5	58772,9	44789,9	68843,3	47232,7	5979,16	8564,28	0	0,548787	800	54
2	1773	367244	95944,5	37117,5	58772,9	44789,9	68843,3	47232,7	5979,16	8564,28	0	0,548787	800	54
3	1773	367440	96139,8	37117,5	58772,9	44789,9	68843,3	47232,7	5979,16	8564,28	0	0,548787	800	54
4	1773	367635	96335,2	37117,5	58772,9	44789,9	68843,3	47232,7	5979,16	8564,28	0	0,548787	800	54
5	1773	367830	96530,6	37117,5	58772,9	44789,9	68843,3	47232,7	5979,16	8564,28	0	0,548787	800	54
6	1773	368026	96544	37226,9	58772,9	44746,3	68843,3	47335,9	5979,16	8577,11	0	0,549915	798	54
7	1773	368220	96677,7	37270,6	58772,9	44734,4	68843,3	47361,7	5979,16	8580,61	0	0,550479	797	54
8	1773	368415	96872,6	37270,6	58772,9	44734,4	68843,3	47361,7	5979,16	8580,61	0	0,550479	797	54
9	1773	368610	97067,4	37270,6	58772,9	44734,4	68843,3	47361,7	5979,16	8580,61	0	0,550479	797	54
10	1773	368805	97262,3	37270,6	58772,9	44734,4	68843,3	47361,7	5979,16	8580,61	0	0,550479	797	54
11	1773	369000	97457,1	37270,6	58772,9	44734,4	68843,3	47361,7	5979,16	8580,61	0	0,550479	797	54
12	1773	369195	97652	37270,6	58772,9	44734,4	68843,3	47361,7	5979,16	8580,61	0	0,550479	797	54
13	1773	369390	97846,8	37270,6	58772,9	44734,4	68843,3	47361,7	5979,16	8580,61	0	0,550479	797	54
14	1773	369584	95056,6	38762,5	58569,4	44011,7	70118,2	48206	6066,66	8793,18	0	0,556684	786	55
15	1773	369774	95246,5	38762,5	58569,4	44011,7	70118,2	48206	6066,66	8793,18	0	0,556684	786	55
16	1773	369964	95436,4	38762,5	58569,4	44011,7	70118,2	48206	6066,66	8793,18	0	0,556684	786	55
17	1773	370154	95626,3	38762,5	58569,4	44011,7	70118,2	48206	6066,66	8793,18	0	0,556684	786	55
18	1773	370344	95816,1	38762,5	58569,4	44011,7	70118,2	48206	6066,66	8793,18	0	0,556684	786	55
19	1773	370534	96006	38762,5	58569,4	44011,7	70118,2	48206	6066,66	8793,18	0	0,556684	786	55
20	1773	370723	96195,9	38762,5	58569,4	44011,7	70118,2	48206	6066,66	8793,18	0	0,556684	786	55
21	1773	370913	96385,8	38762,5	58569,4	44011,7	70118,2	48206	6066,66	8793,18	0	0,556684	786	55
22	1773	371103	96575,6	38762,5	58569,4	44011,7	70118,2	48206	6066,66	8793,18	0	0,556684	786	55
23	1773	371293	96765,5	38762,5	58569,4	44011,7	70118,2	48206	6066,66	8793,18	0	0,556684	786	55
24	1773	371483	96955,4	38762,5	58569,4	44011,7	70118,2	48206	6066,66	8793,18	0	0,556684	786	55
25	1773	371673	97145,3	38762,5	58569,4	44011,7	70118,2	48206	6066,66	8793,18	0	0,556684	786	55
26	1773	371863	97335,1	38762,5	58569,4	44011,7	70118,2	48206	6066,66	8793,18	0	0,556684	786	55
27	1773	372053	97525	38762,5	58569,4	44011,7	70118,2	48206	6066,66	8793,18	0	0,556684	786	55
28	1773	372242	97714,9	38762,5	58569,4	44011,7	70118,2	48206	6066,66	8793,18	0	0,556684	786	55
29	1773	372432	97904,8	38762,5	58569,4	44011,7	70118,2	48206	6066,66	8793,18	0	0,556684	786	55
30	1773	372622	98094,6	38762,5	58569,4	44011,7	70118,2	48206	6066,66	8793,18	0	0,556684	786	55
31	1773	372812	98207,9	38819,4	58569,4	44010,2	70118,2	48226,7	6066,66	8793,63	0	0,557248	785	55
32	1773	373002	98397,6	38819,4	58569,4	44010,2	70118,2	48226,7	6066,66	8793,63	0	0,557248	785	55
33	1773	373191	98587,3	38819,4	58569,4	44010,2	70118,2	48226,7	6066,66	8793,63	0	0,557248	785	55
34	1773	373381	98777	38819,4	58569,4	44010,2	70118,2	48226,7	6066,66	8793,63	0	0,557248	785	55
35	1773	373571	98966,7	38819,4	58569,4	44010,2	70118,2	48226,7	6066,66	8793,63	0	0,557248	785	55
36	1773	373760	99118,7	38850	58569,4	43976,1	70118,2	48257,7	6066,66	8803,64	0	0,557248	785	55
37	1773	373950	99059,2	38933,1	58488,4	44157	70118,2	48355,7	6087,66	8750,44	0	0,557812	784	55
38	1773	374139	99248,5	38933,1	58488,4	44157	70118,2	48355,7	6087,66	8750,44	0	0,557812	784	55
39	1773	374328	99437,8	38933,1	58488,4	44157	70118,2	48355,7	6087,66	8750,44	0	0,557812	784	55
40	1773	374518	99627,1	38933,1	58488,4	44157	70118,2	48355,7	6087,66	8750,44	0	0,557812	784	55

41	1773	374707	99816,4	38933,1	58488,4	44157	70118,2	48355,7	6087,66	8750,44	0	0,557812	784	55
42	1773	374896	100006	38933,1	58488,4	44157	70118,2	48355,7	6087,66	8750,44	0	0,557812	784	55
43	1773	375086	100195	38933,1	58488,4	44157	70118,2	48355,7	6087,66	8750,44	0	0,557812	784	55
44	1773	375275	100357	38955	58488,4	44091,8	70118,2	48407,4	6087,66	8769,63	0	0,557812	784	55
45	1773	375464	100546	38955	58488,4	44091,8	70118,2	48407,4	6087,66	8769,63	0	0,557812	784	55
46	1773	375652	99756,3	39554,4	58584,7	43569,2	70118,2	49114,6	6031,08	8923,33	0	0,55894	782	55
47	1773	375839	99821	39641,9	58584,7	43545,4	70118,2	49166,3	6031,08	8930,33	0	0,559504	781	55
48	1773	376026	100008	39641,9	58584,7	43545,4	70118,2	49166,3	6031,08	8930,33	0	0,559504	781	55
49	1773	376213	100195	39641,9	58584,7	43545,4	70118,2	49166,3	6031,08	8930,33	0	0,559504	781	55
50	1773	376399	100229	39729,4	58584,7	43490,9	70118,2	49269,5	6031,08	8946,38	0	0,560068	780	55
51	1773	376586	100416	39729,4	58584,7	43490,9	70118,2	49269,5	6031,08	8946,38	0	0,560068	780	55
52	1773	376773	100603	39729,4	58584,7	43490,9	70118,2	49269,5	6031,08	8946,38	0	0,560068	780	55
53	1773	376959	100789	39729,4	58584,7	43490,9	70118,2	49269,5	6031,08	8946,38	0	0,560068	780	55
54	1773	377146	100976	39729,4	58584,7	43490,9	70118,2	49269,5	6031,08	8946,38	0	0,560068	780	55
55	1773	377333	101163	39729,4	58584,7	43490,9	70118,2	49269,5	6031,08	8946,38	0	0,560068	780	55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378000
376000
374000
372000
370000
368000
366000
364000
362000
360000
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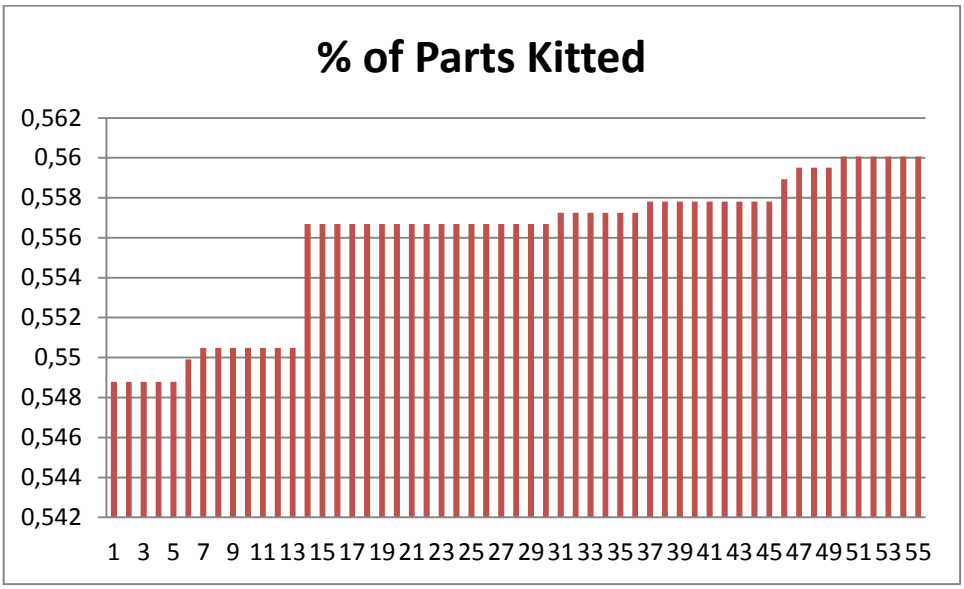
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0,558
0,556
0,554
0,552
0,55
0,548
0,546
0,544
0,542
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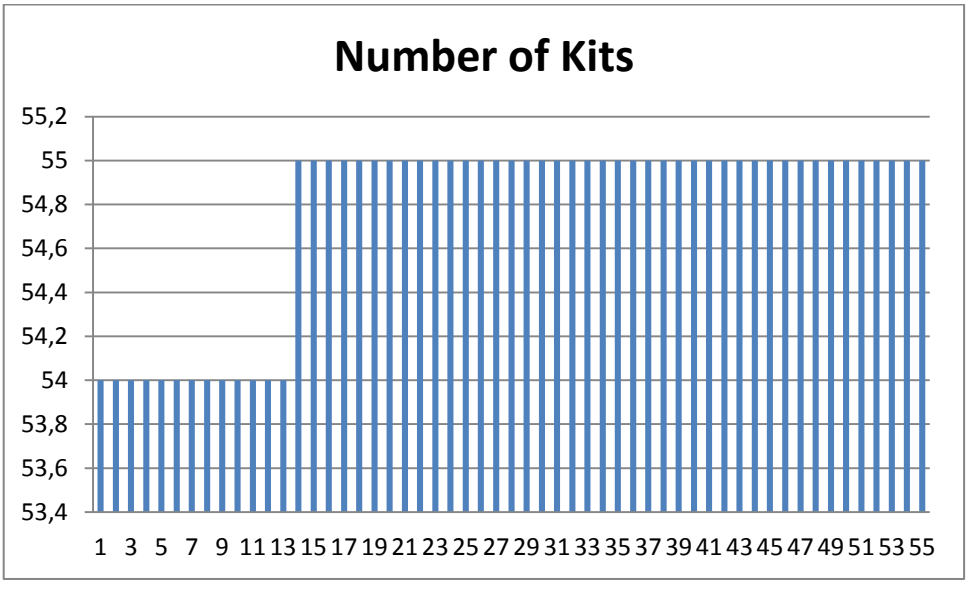
Number of Kits
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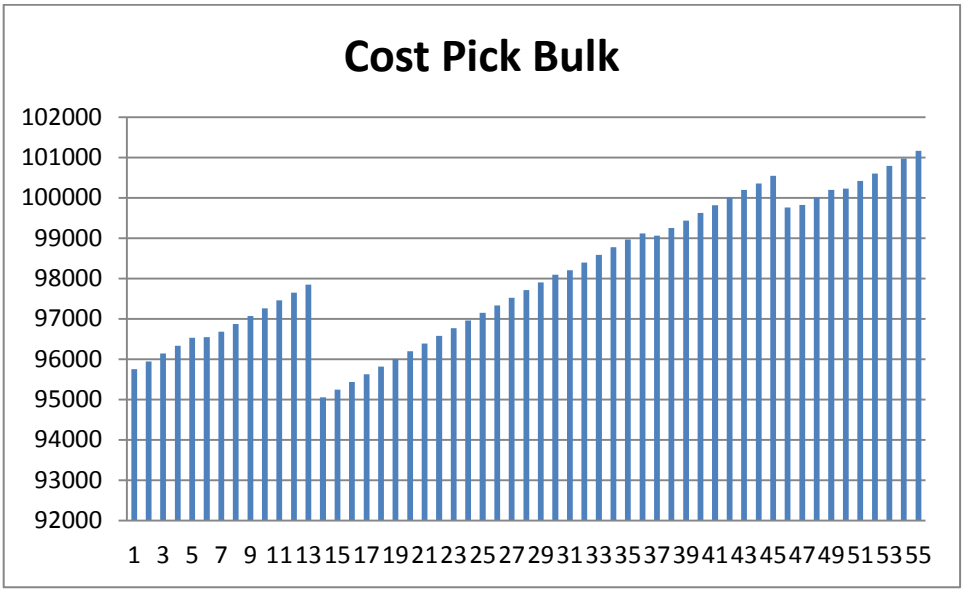
55
54,8
54,6
54,4
54,2
54
53,8
53,6
53,4
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55


Cost Pick Bulk
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101000
100000
99000
98000
97000
96000
95000
94000
93000
92000
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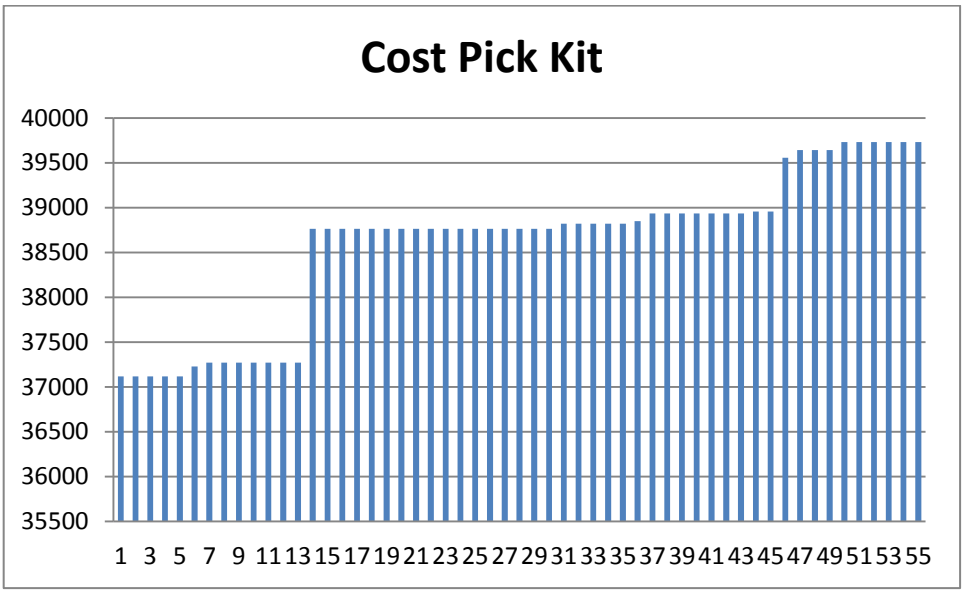
Cost Pick Kit
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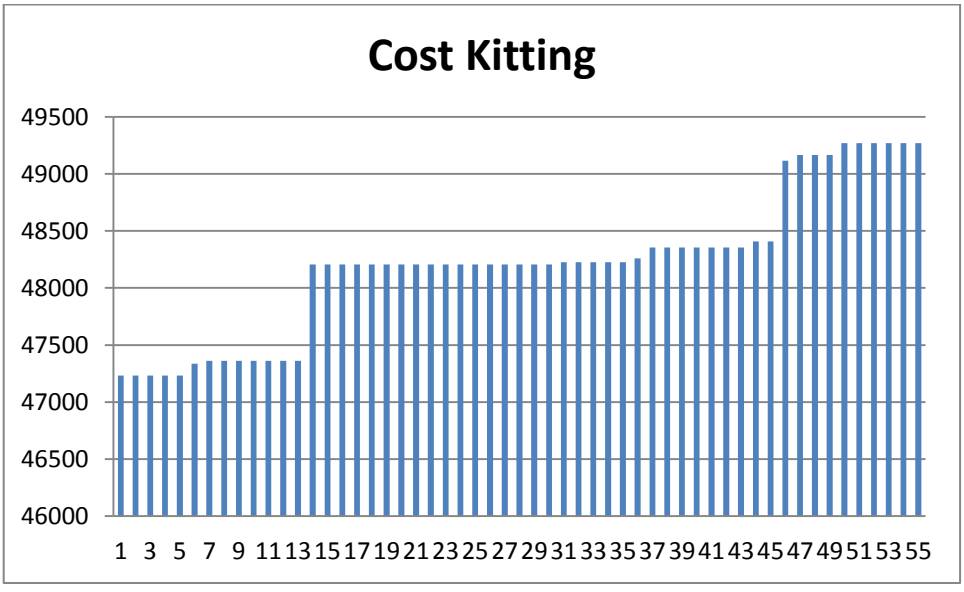
39500
39000
38500
38000
37500
37000
36500
36000
35500
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55


Cost Kitting
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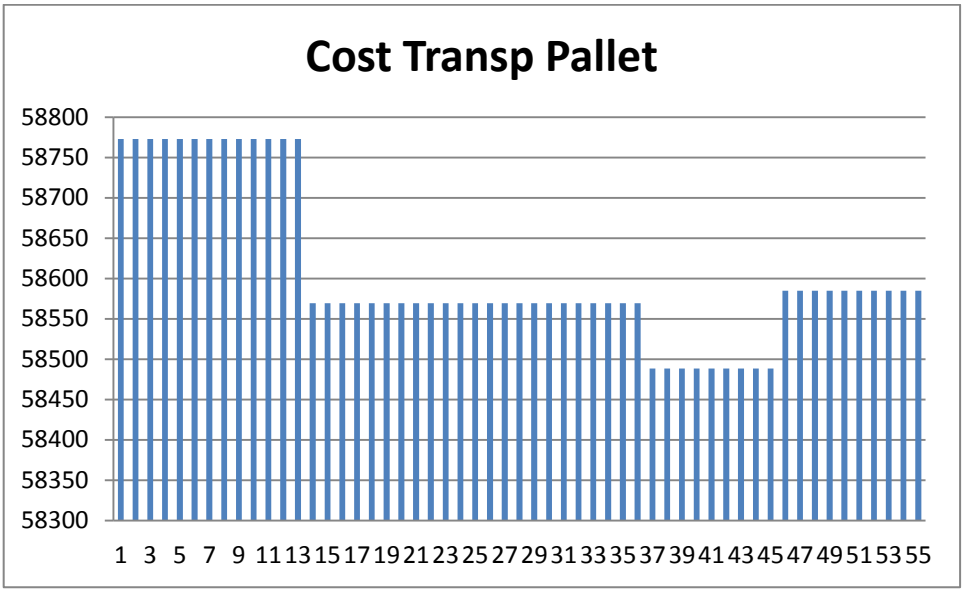
49000
48500
48000
47500
47000
46500
46000
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55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58750
58700
58650
58600
58550
58500
58450
58400
58350
58300
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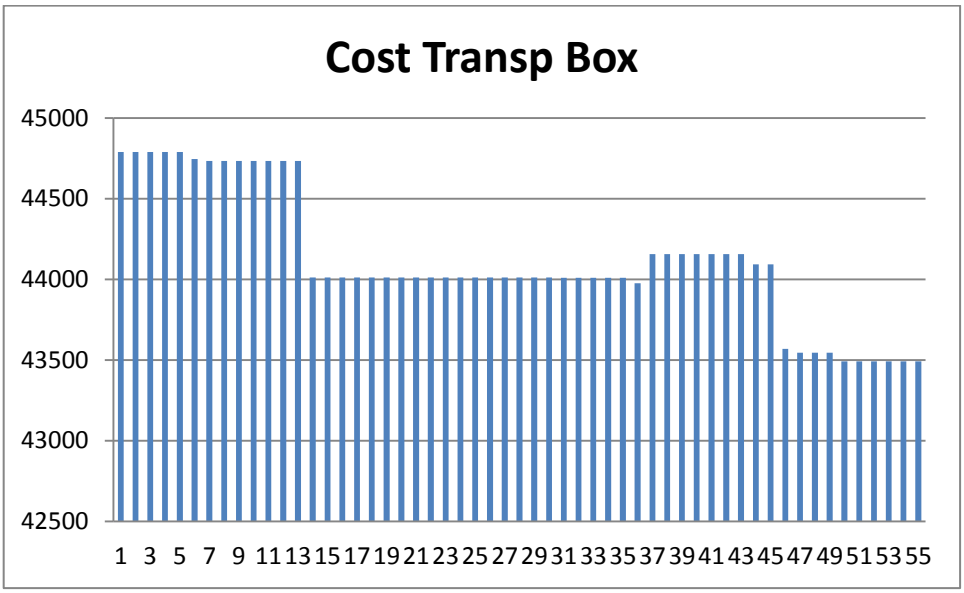
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44500
44000
43500
43000
42500
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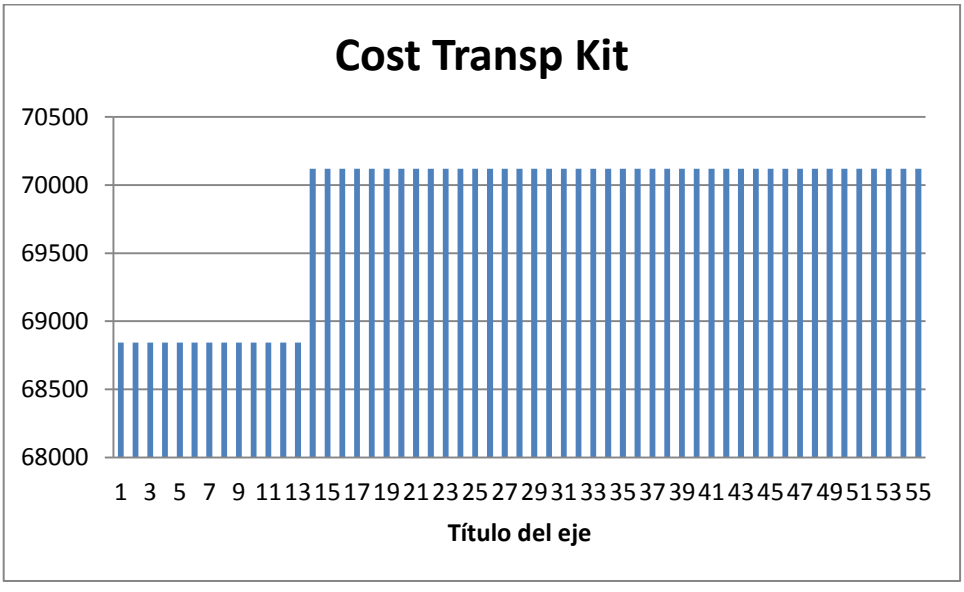
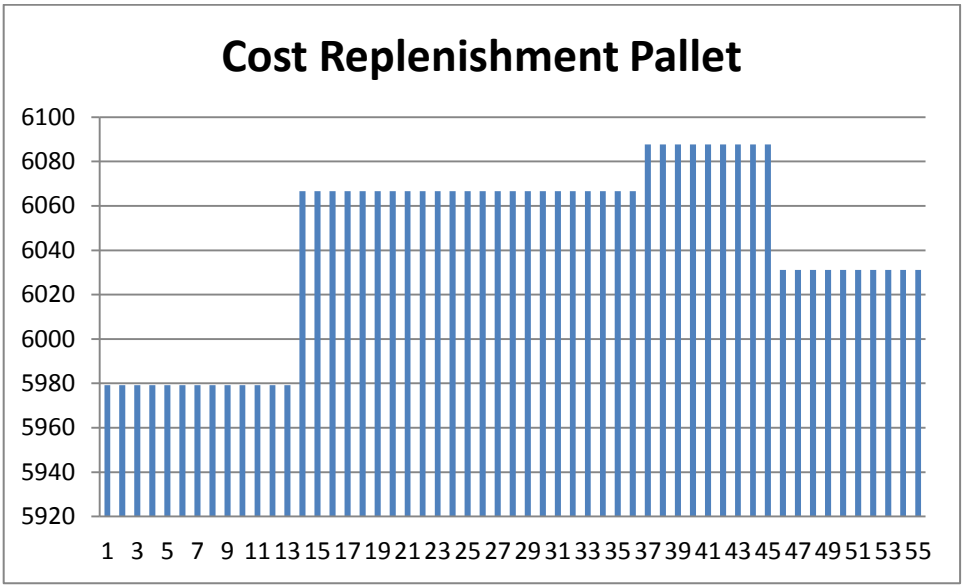

Cost Transp Kit
70500
70000
69500
69000
68500
68000
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55
Título del eje


Cost Replenishment Pallet
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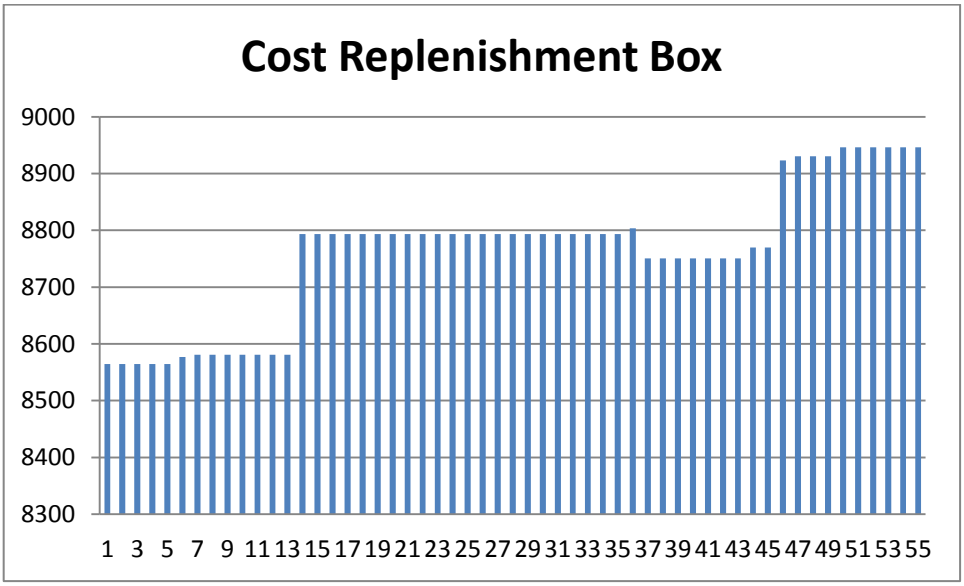
6080
6060
6040
6020
6000
5980
5960
5940
5920
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55


Cost Replenishment Box
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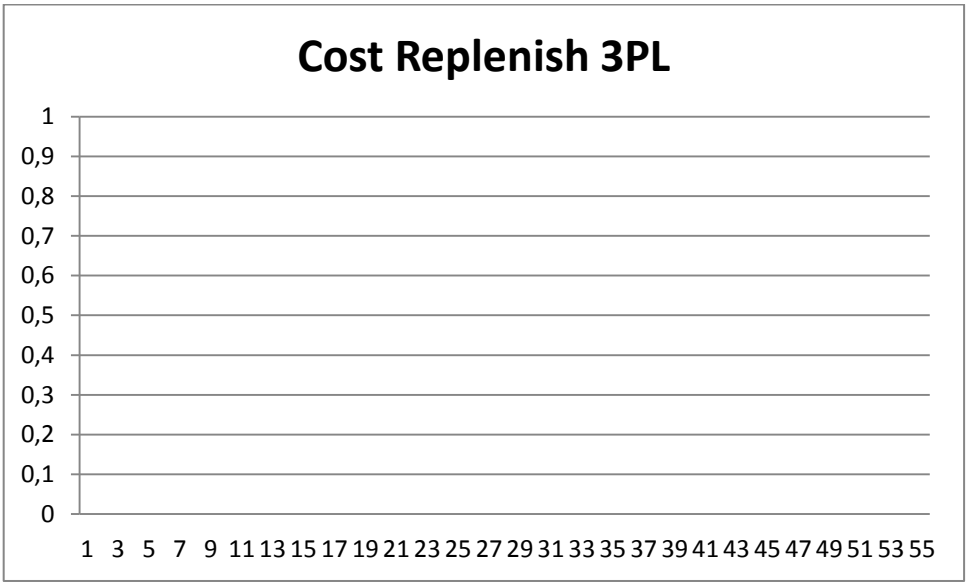
8900
8800
8700
8600
8500
8400
8300
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55


Cost Replenish 3PL
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55

2.3 Outsourcing: Impact of the labour cost

TEMPLATE

LOWER VALUE	UPPER VALUE	STEP VALUE	units	# of results	# total results
OPERARI_COST_lower	OPERARI_COST_upper	OPERARI_COST_step			16
30	30	10	€/h	1	
OPERARI_COST_LOGISTIC_lower	OPERARI_COST_LOGISTIC_upper	OPERARI_COST_LOGISTIC_step			
15	30	1	€/h	16	
MAXIMUM_WEIGHT_lower	MAXIMUM_WEIGHT_upper	MAXIMUM_WEIGHT_step			
30	30	2	Kg	1	
MILK_RUN_TOUR_KIT_lower	MILK_RUN_TOUR_KIT_upper	MILK_RUN_TOUR_KIT_step			
1640	1640	100	m	1	
MILK_RUN_TOUR_BOX_lower	MILK_RUN_TOUR_BOX_upper	MILK_RUN_TOUR_BOX_step			
1640	1640	100	m	1	
SEARCH_TIME_KIT_lower	SEARCH_TIME_KIT_upper	SEARCH_TIME_KIT_step			
0,54	0,54	0,01	s	1	
SEARCH_TIME_BULK_lower	SEARCH_TIME_BULK_upper	SEARCH_TIME_BULK_step			
1,08	1,08	0,01	s	1	
BATCH_SIZE_lower	BATCH_SIZE_upper	BATCH_SIZE_step			
5	5	4	kit	1	
LENGTH_FACTOR_lower	LENGTH_FACTOR_upper	LENGTH_FACTOR_step			
1	1	0,1	-	1	
TRANSPORT_VELOCITY_BOX_lower	TRANSPORT_VELOCITY_BOX_upper	TRANSPORT_VELOCITY_BOX_step			
2412	2412	50	m/h	1	
TRANSPORT_VELOCITY_PALLET_lower	TRANSPORT_VELOCITY_PALLET_upper	TRANSPORT_VELOCITY_PALLET_step			
2880	2880	50	m/h	1	
TRANSPORT_VELOCITY_KIT_lower	TRANSPORT_VELOCITY_KIT_upper	TRANSPORT_VELOCITY_KIT_step			
2412	2412	50	m/h	1	
CAPACITY_MRT_BOX_lower	CAPACITY_MRT_BOX_upper	CAPACITY_MRT_BOX_step			
60	60	10	box	1	
CAPACITY_MRT_KIT_lower	CAPACITY_MRT_KIT_upper	CAPACITY_MRT_KIT_step			
70	70	10	kit	1	
CONSTANT_REPLENISH_BOX_lower	CONSTANT_REPLENISH_BOX_upper	CONSTANT_REPLENISH_BOX_step			
0,2	0,2	0,2	€	1	
CONSTANT_REPLENISH_PALLET_lower	CONSTANT_REPLENISH_PALLET_upper	CONSTANT_REPLENISH_PALLET_step			
1,2	1,2	0,6	€	1	
VOLUME_FACTOR_lower	VOLUME_FACTOR_upper	VOLUME_FACTOR_step			
1	1	0,1	-	1	
DISTANCE_PALLET_FACTOR_lower	DISTANCE_PALLET_FACTOR_upper	DISTANCE_PALLET_FACTOR_step			
1	1	0,3	-	1	
CONSTANT_REPLENISH_3PL_lower	CONSTANT_REPLENISH_3PL_upper	CONSTANT_REPLENISH_3PL_step			
0	0	0,1		1	

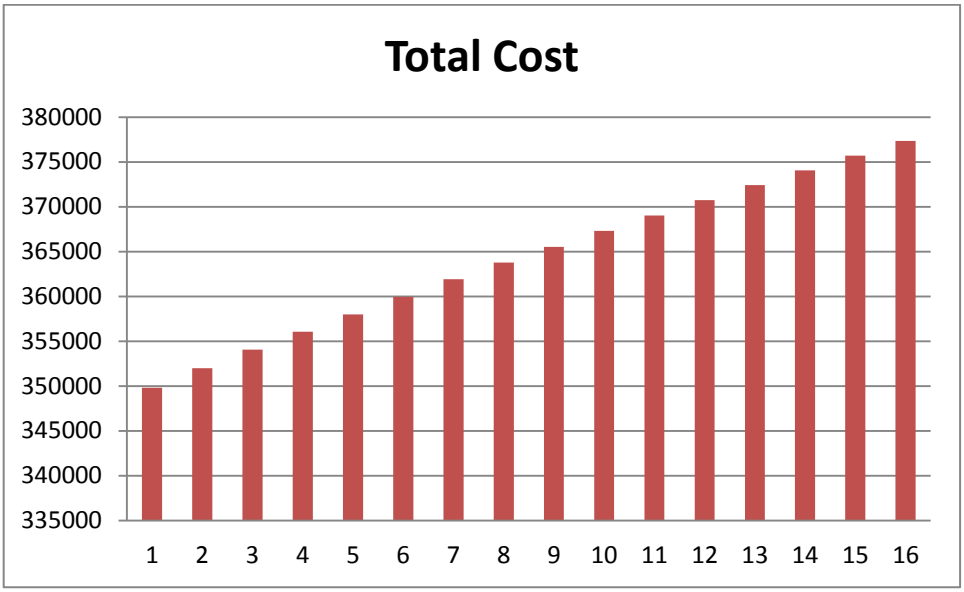
Parameter's values combinations

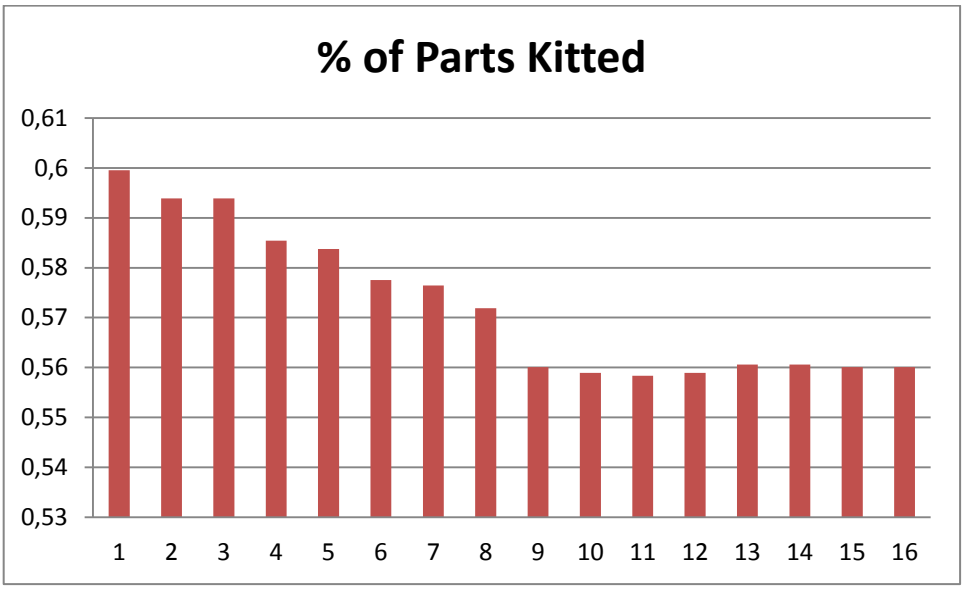
Obtain Combinations

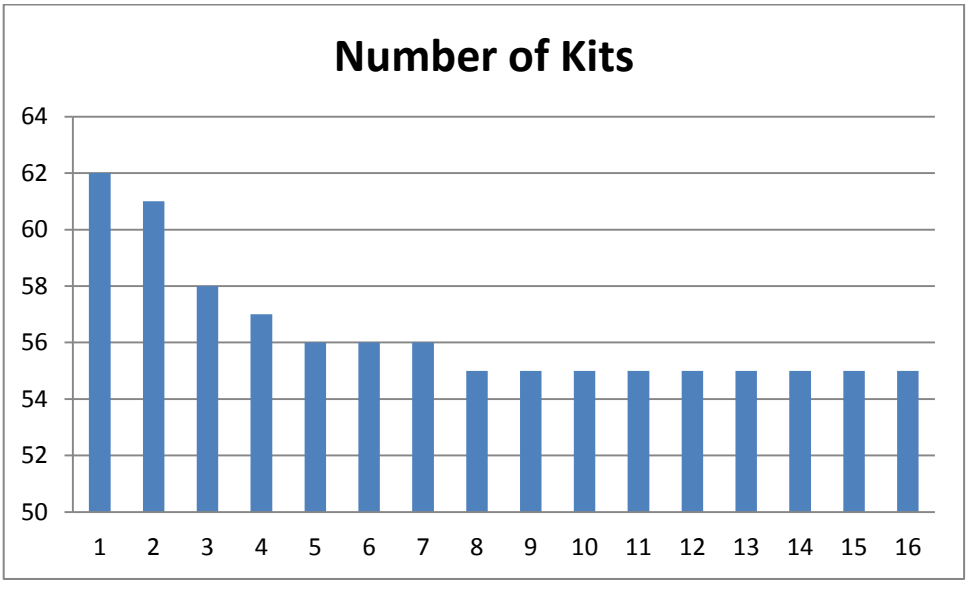
#	OC	OCL	w^k	D^k	D^b	τ^k	τ^{bulk}	B^k	L^{fact}	V^b	V^p	V^k	A^b	A^k	R^b	R^p	V^{fact}	Dp^{fact}	R^{3PL}
Number of result	Operari Cost	Operari Cost Logistic	Maximum weight	Milk Run Tour Kit	Milk Run Tour Box	Search Time Kit	Search Time Bulk	Batch Size	Length Factor	Transport Velocity Box	Transport Velocity Pallet	Transport Velocity Kit	Capacity MRT Box	Capacity MRT Kit	Constant Replenish Box	Constant Replenish Pallet	Volume Factor	Distance Pallet Factor	Constant Replenish 3PL
1	30	15	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
2	30	16	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
3	30	17	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
4	30	18	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
5	30	19	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
6	30	20	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
7	30	21	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
8	30	22	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
9	30	23	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
10	30	24	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
11	30	25	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
12	30	26	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
13	30	27	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
14	30	28	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
15	30	29	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
16	30	30	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0

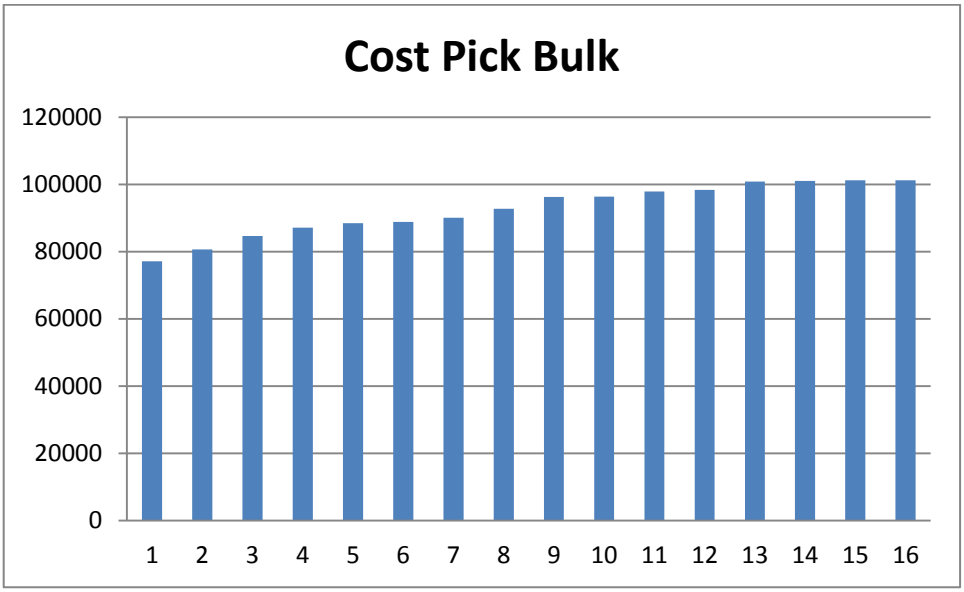
TABLE OF RESULTS

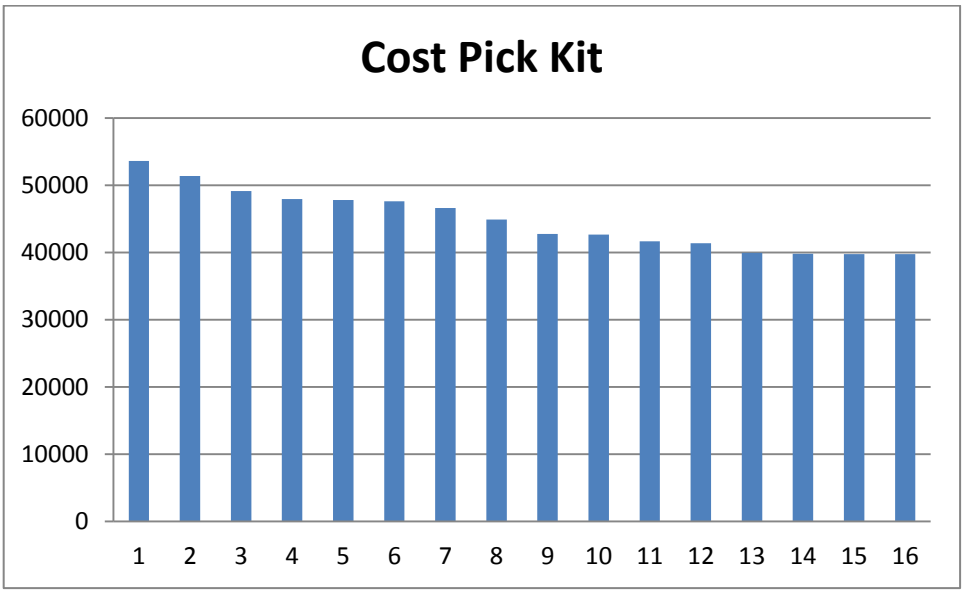
Num.	Num of parts	Total Cost	Cost pick bulk	Cost pick kit	Cost transp pal	Cost transp box	Cost transp kit	Cost of kitting	Cost Repl Pal	Cost Repl box	Cost repl 3PL	Percentage of parts kitted	Number of parts bulked	Number of kits used
Num.	card(COMBI) =	Total_Cost =	Cost_pick_bulk =	Cost_pick_kit =	Cost_Transp_pal =	Cost_Transp_box =	Cost_Transp_kit =	Cost_Kitting =	Cost_Repl_pal =	Cost_Repl_box =	Cost_Repl_3pl =	(sum{(i,s) in COMBI} (1 - x[i,	sum{(i,s) in COMBI} x[i,s]	sum{s in S} K[s] =
1	1773	349806	77161,3	53580,6	59448,5	28278	79042,3	33100,7	5773,7	13421,2	0	0,599549	710	62
2	1773	351982	80672,4	51384,4	59448,5	29671	77767,4	34252,8	5773,7	13011,5	0	0,593909	720	61
3	1773	354069	84600,5	49140	59795,9	35304,9	73942,8	34247,4	5683,57	11354,2	0	0,593909	720	58
4	1773	356046	87140,3	47958,7	59982,9	35927,9	72667,9	35580,4	5617,11	11171	0	0,585448	735	57
5	1773	358008	88463,2	47810	60602,6	35927,9	71393	37261,1	5379,11	11171	0	0,583756	738	56
6	1773	359965	88859,6	47600	60312,1	36073,3	71393	39081,1	5518,11	11128,2	0	0,577552	749	56
7	1773	361909	90035,2	46624,4	59781,8	37382,1	71393	40290,7	5658,65	10743,2	0	0,576424	751	56
8	1773	363768	92757,2	44900,6	59359,3	40528,6	70118,2	40518,8	5767,2	9817,71	0	0,571912	759	55
9	1773	365537	96257,1	42739,4	58865,4	41772,7	70118,2	40425,1	5907,47	9451,77	0	0,560068	780	55
10	1773	367295	96353,3	42665	58865,4	41776,7	70118,2	42157,9	5907,47	9450,58	0	0,55894	782	55
11	1773	369017	97882,4	41658,7	58734,1	42456,4	70118,2	42925	5991,47	9250,67	0	0,558376	783	55
12	1773	370728	98321,7	41370	58766,6	42645,4	70118,2	44346,7	5964,77	9195,06	0	0,55894	782	55
13	1773	372401	100832	39926,2	58584,7	43422,8	70118,2	44519,1	6031,08	8966,39	0	0,560632	779	55
14	1773	374048	101020	39816,9	58584,7	43431,4	70118,2	46081,2	6031,08	8963,88	0	0,560632	779	55
15	1773	375690	101163	39729,4	58584,7	43490,9	70118,2	47627,2	6031,08	8946,38	0	0,560068	780	55
16	1773	377333	101163	39729,4	58584,7	43490,9	70118,2	49269,5	6031,08	8946,38	0	0,560068	780	55

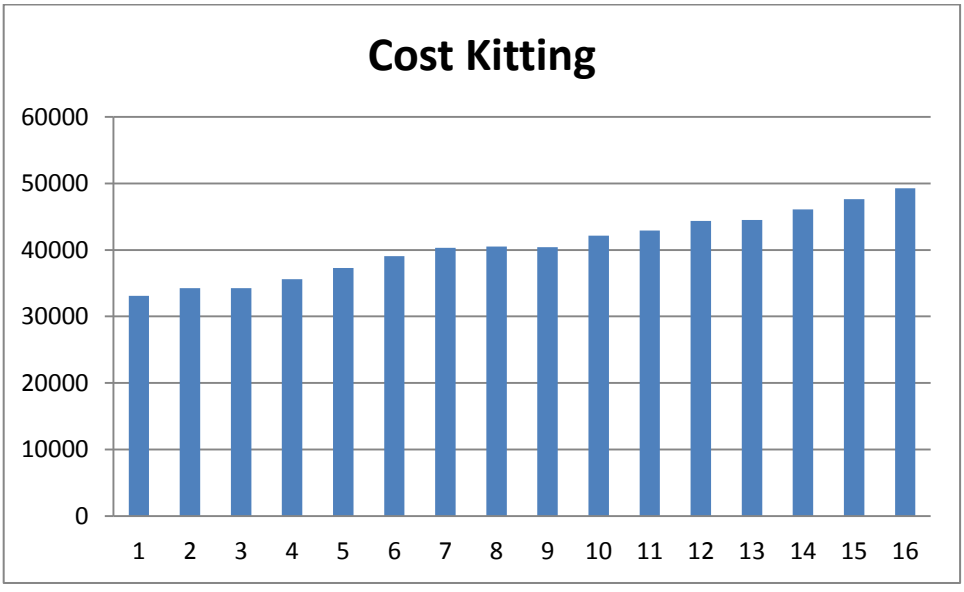

Total Cost
380000
375000
370000
365000
360000
355000
350000
345000
340000
335000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

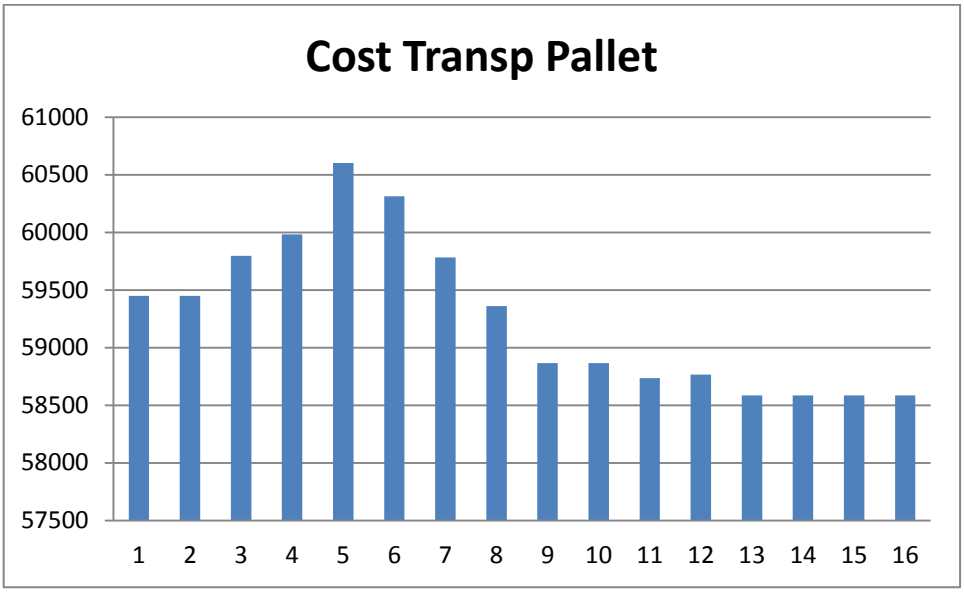

% of Parts Kitted
0,61
0,6
0,59
0,58
0,57
0,56
0,55
0,54
0,53
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

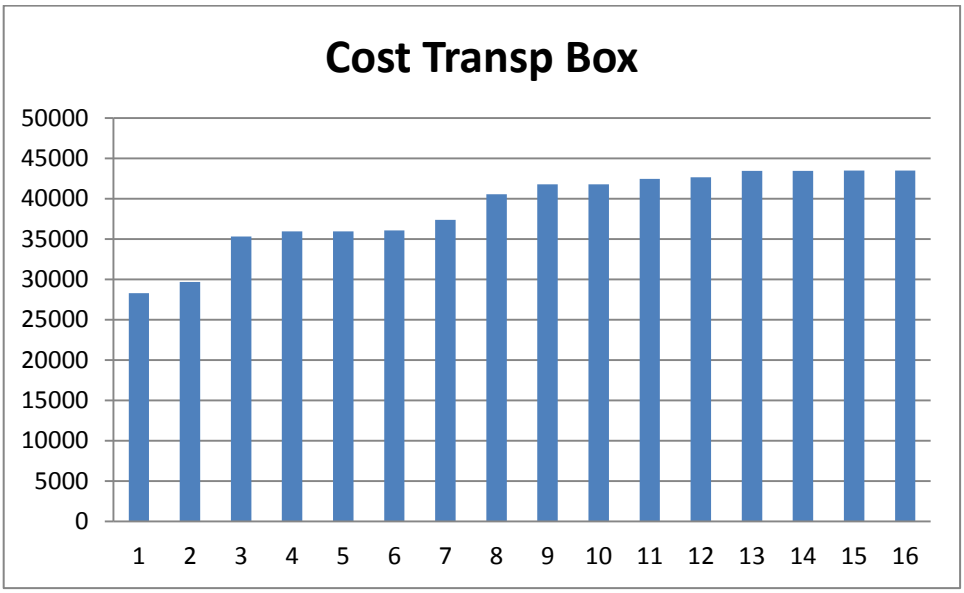

Number of Kits
64
62
60
58
56
54
52
50
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

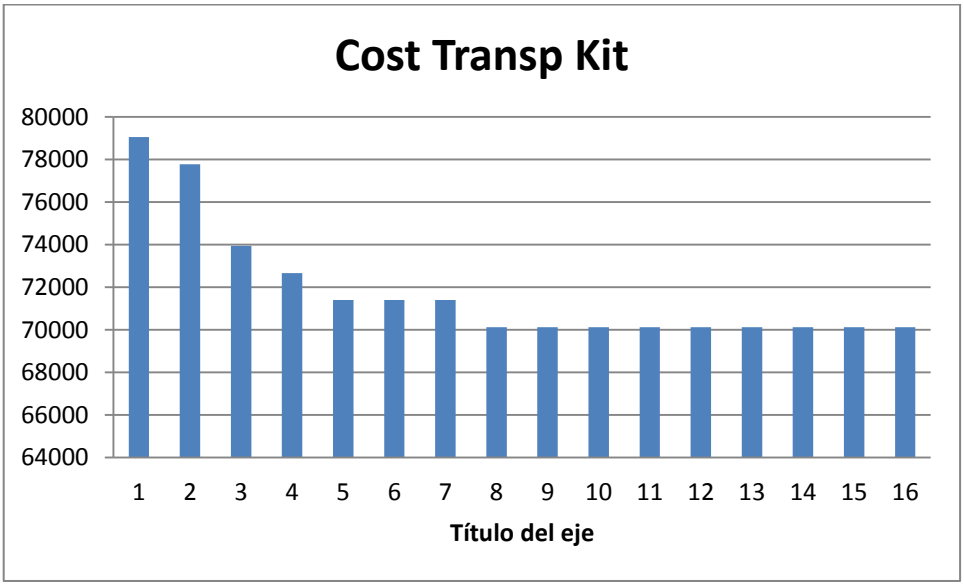

Cost Pick Bulk
120000
100000
80000
60000
40000
20000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

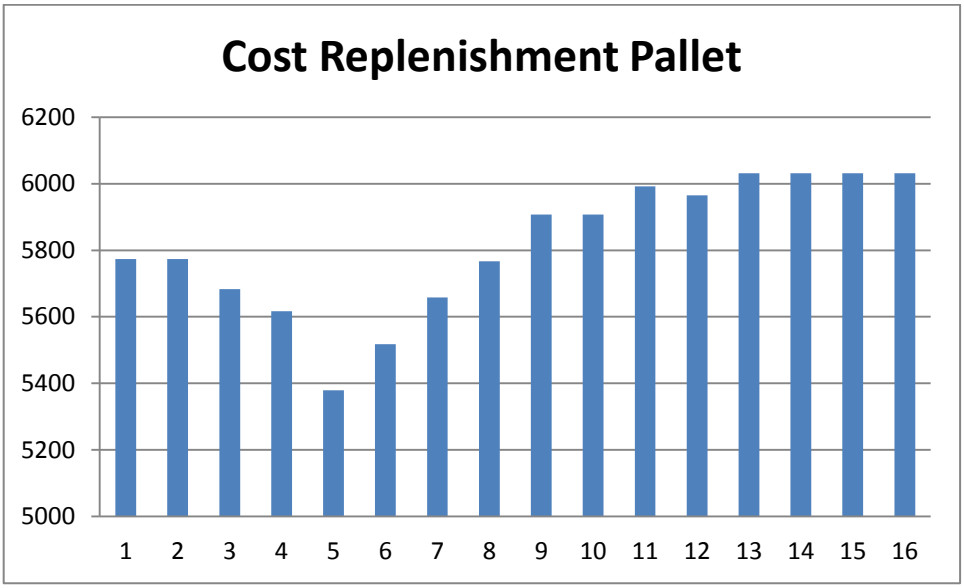

Cost Pick Kit
60000
50000
40000
30000
20000
10000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

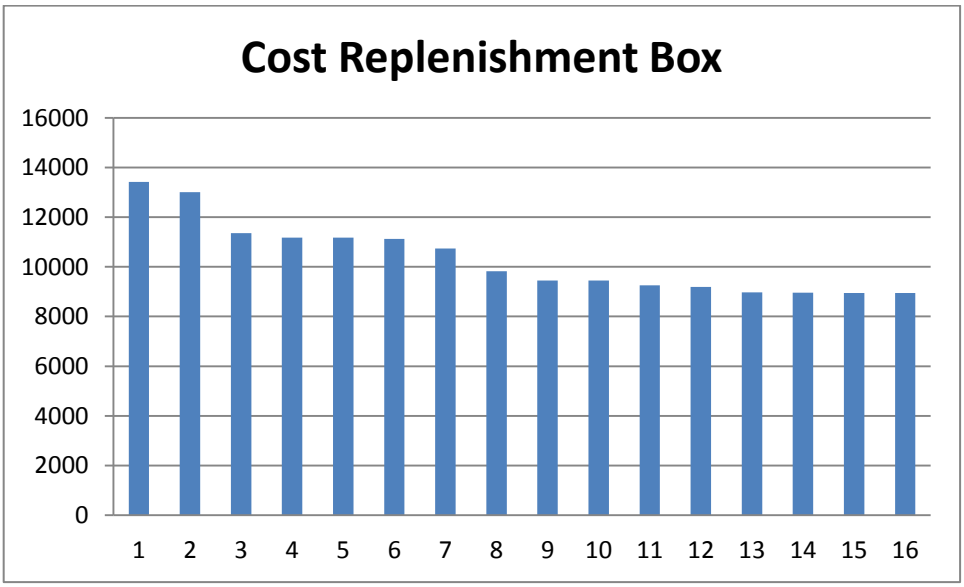

Cost Kitting
60000
50000
40000
30000
20000
10000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

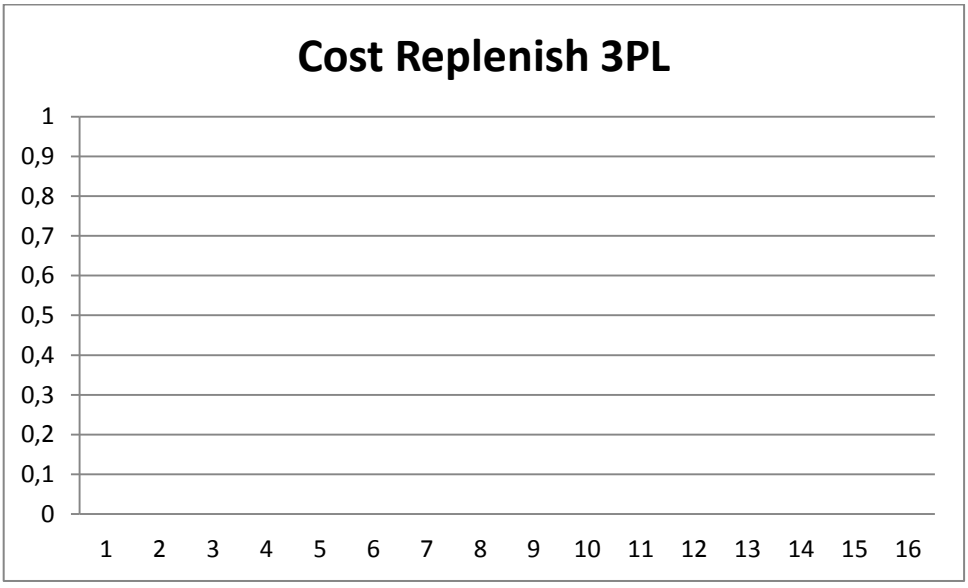

Cost Transp Pallet
61000
60500
60000
59500
59000
58500
58000
57500
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16


Cost Transp Box
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16


Cost Transp Kit
80000
78000
76000
74000
72000
70000
68000
66000
64000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Título del eje


Cost Replenishment Pallet
6200
6000
5800
5600
5400
5200
5000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16


Cost Replenishment Box
16000
14000
12000
10000
8000
6000
4000
2000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16


Cost Replenish 3PL
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

2.4 Outsourcing: Impact of the distance

TEMPLATE

LOWER VALUE	UPPER VALUE	STEP VALUE	units	# of results	# total results
OPERARI_COST_lower	OPERARI_COST_upper	OPERARI_COST_step			11
30	30	10	€/h	1	
OPERARI_COST_LOGISTIC_lower	OPERARI_COST_LOGISTIC_upper	OPERARI_COST_LOGISTIC_step			
20	20	1	€/h	1	
MAXIMUM_WEIGHT_lower	MAXIMUM_WEIGHT_upper	MAXIMUM_WEIGHT_step			
30	30	2	Kg	1	
MILK_RUN_TOUR_KIT_lower	MILK_RUN_TOUR_KIT_upper	MILK_RUN_TOUR_KIT_step			
1640	1640	100	m	1	
MILK_RUN_TOUR_BOX_lower	MILK_RUN_TOUR_BOX_upper	MILK_RUN_TOUR_BOX_step			
1640	1640	100	m	1	
SEARCH_TIME_KIT_lower	SEARCH_TIME_KIT_upper	SEARCH_TIME_KIT_step			
0,54	0,54	0,01	s	1	
SEARCH_TIME_BULK_lower	SEARCH_TIME_BULK_upper	SEARCH_TIME_BULK_step			
1,08	1,08	0,01	s	1	
BATCH_SIZE_lower	BATCH_SIZE_upper	BATCH_SIZE_step			
5	5	4	kit	1	
LENGTH_FACTOR_lower	LENGTH_FACTOR_upper	LENGTH_FACTOR_step			
1	1	0,1	-	1	
TRANSPORT_VELOCITY_BOX_lower	TRANSPORT_VELOCITY_BOX_upper	TRANSPORT_VELOCITY_BOX_step			
2412	2412	50	m/h	1	
TRANSPORT_VELOCITY_PALLET_lower	TRANSPORT_VELOCITY_PALLET_upper	TRANSPORT_VELOCITY_PALLET_step			
2880	2880	50	m/h	1	
TRANSPORT_VELOCITY_KIT_lower	TRANSPORT_VELOCITY_KIT_upper	TRANSPORT_VELOCITY_KIT_step			
2412	2412	50	m/h	1	
CAPACITY_MRT_BOX_lower	CAPACITY_MRT_BOX_upper	CAPACITY_MRT_BOX_step			
60	60	10	box	1	
CAPACITY_MRT_KIT_lower	CAPACITY_MRT_KIT_upper	CAPACITY_MRT_KIT_step			
70	70	10	kit	1	
CONSTANT_REPLENISH_BOX_lower	CONSTANT_REPLENISH_BOX_upper	CONSTANT_REPLENISH_BOX_step			
0	0	0,2	€	1	
CONSTANT_REPLENISH_PALLET_lower	CONSTANT_REPLENISH_PALLET_upper	CONSTANT_REPLENISH_PALLET_step			
0	0	0,6	€	1	
VOLUME_FACTOR_lower	VOLUME_FACTOR_upper	VOLUME_FACTOR_step			
1	1	0,1	-	1	
DISTANCE_PALLET_FACTOR_lower	DISTANCE_PALLET_FACTOR_upper	DISTANCE_PALLET_FACTOR_step			
1	1	0,3	-	1	
CONSTANT_REPLENISH_3PL_lower	CONSTANT_REPLENISH_3PL_upper	CONSTANT_REPLENISH_3PL_step			
0	1	0,1		11	

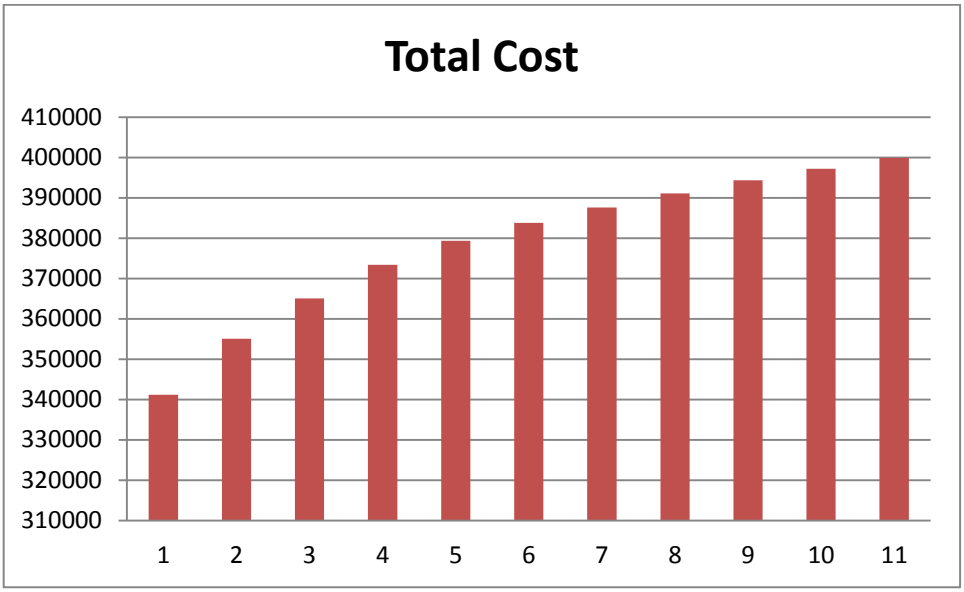
Parameter's values combinations

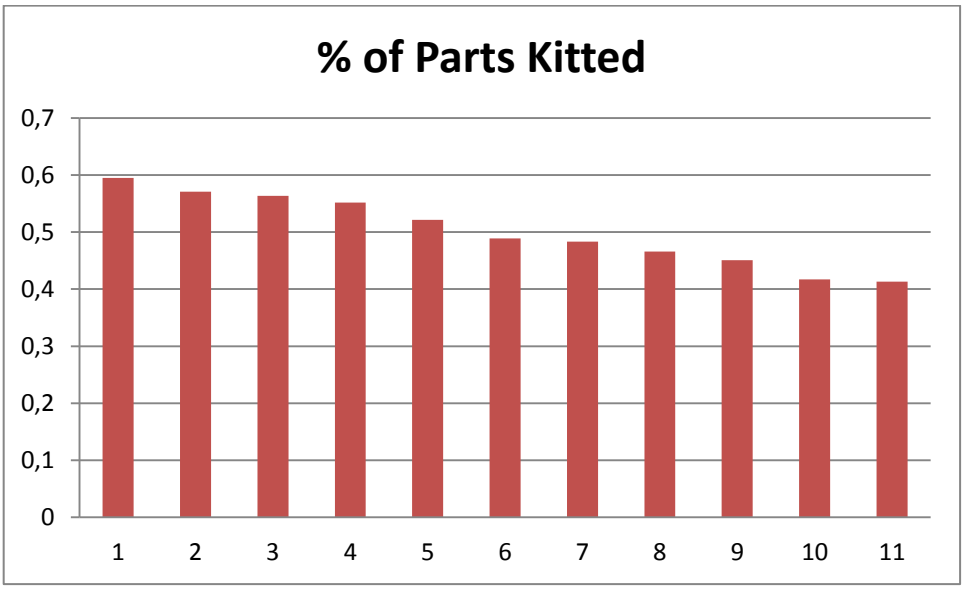
Obtain Combinations

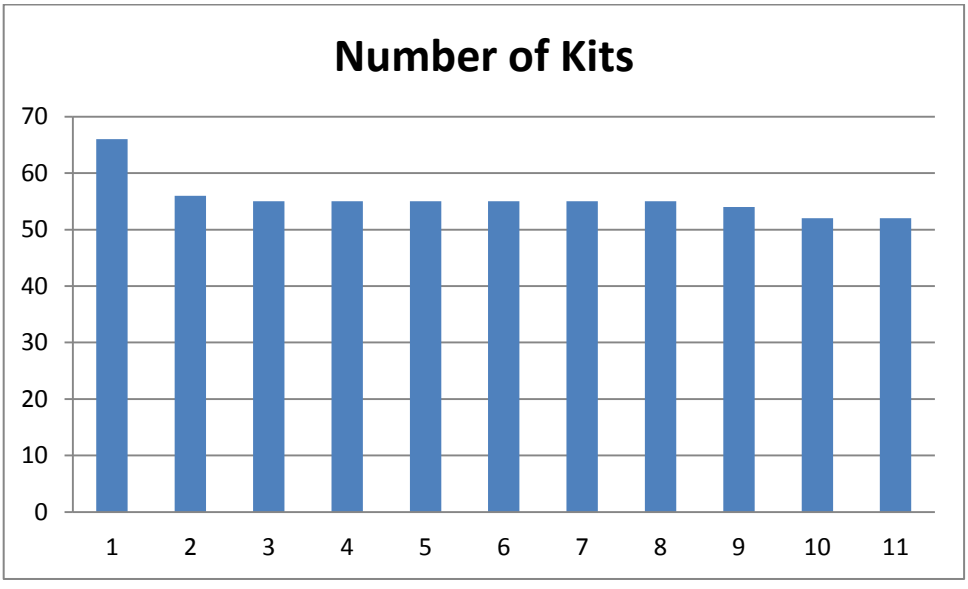
#	OC	OCL	w^k	D^k	D^b	τ^k	τ^{bulk}	B^k	L^{fact}	V^b	V^p	V^k	A^b	A^k	R^b	R^p	V^{fact}	Dp^{fact}	R^{3PL}
Number of result	Operari Cost	Operari Cost Logistic	Maximum weight	Milk Run Tour Kit	Milk Run Tour Box	Search Time Kit	Search Time Bulk	Batch Size	Length Factor	Transport Velocity Box	Transport Velocity Pallet	Transport Velocity Kit	Capacity MRT Box	Capacity MRT Kit	Constant Replenish Box	Constant Replenish Pallet	Volume Factor	Distance Pallet Factor	Constant Replenish 3PL
1	30	20	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0	0	1	1	0
2	30	20	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0	0	1	1	0,1
3	30	20	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0	0	1	1	0,2
4	30	20	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0	0	1	1	0,3
5	30	20	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0	0	1	1	0,4
6	30	20	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0	0	1	1	0,5
7	30	20	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0	0	1	1	0,6
8	30	20	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0	0	1	1	0,7
9	30	20	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0	0	1	1	0,8
10	30	20	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0	0	1	1	0,9
11	30	20	30	1640	1640	0,54	1,08	5	1	2412	2880	2412	60	70	0	0	1	1	1

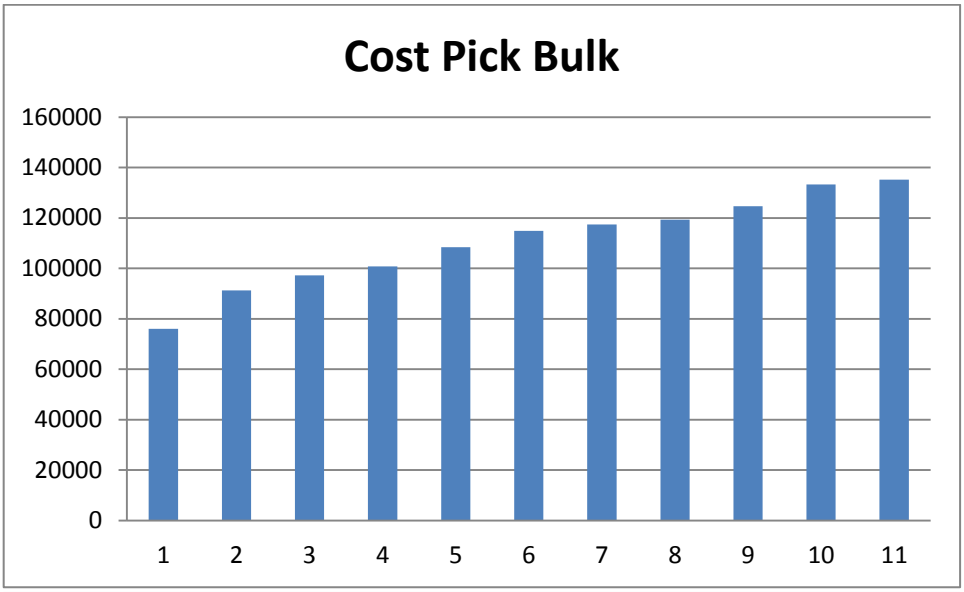
TABLE OF RESULTS

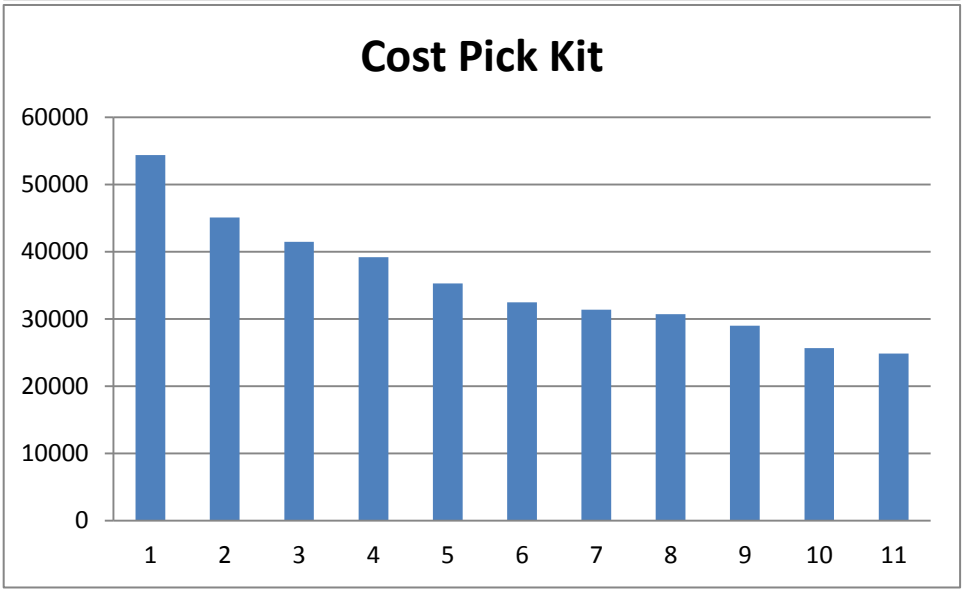
Num.	Num of parts	Total Cost	Cost pick bulk	Cost pick kit	Cost transp pal	Cost transp box	Cost transp kit	Cost of kitting	Cost Repl Pal	Cost Repl box	Cost repl 3PL	Percentage of parts kitted	Number of parts bulked	Number of kits used
Num.	card(COMBI) =	Total_Cost =	Cost_pick_bulk =	Cost_pick_kit =	Cost_Transp_pal =	Cost_Transp_box =	Cost_Transp_kit =	Cost_Kitting =	Cost_Repl_pal =	Cost_Repl_box =	Cost_Repl_3pl =	(sum{(i,s) in COMBI} (1 - x[i,	sum{(i,s) in COMBI} x[i,s] =	sum{s in S} K[s] =
1	1773	341166	76084,4	54355	59423,9	21584,4	84141,8	45576,9	0	0	0	0,595037	718	66
2	1773	355039	91244,4	45062,5	57908,6	41797,8	71393	37143,4	0	0	10488,7	0,570784	761	56
3	1773	365033	97210,7	41466,2	57125,7	46947,2	70118,2	34133,5	0	0	18031,5	0,563452	774	55
4	1773	373356	100809	39165	56039,6	52842,3	70118,2	32306	0	0	22076,3	0,551607	795	55
5	1773	379377	108368	35258,1	55443,9	61300,3	70118,2	29215,4	0	0	19673,5	0,521151	849	55
6	1773	383790	114944	32440,6	54872,4	64673,8	70118,2	27019,6	0	0	19721,1	0,489002	906	55
7	1773	387611	117366	31368,7	54872,4	65496,8	70118,2	26176,4	0	0	22212,8	0,483362	916	55
8	1773	391106	119340	30686,2	54872,4	66431,4	70118,2	25667	0	0	23990,5	0,465877	947	55
9	1773	394363	124692	28984,4	55371,5	67437,6	68843,3	24250,6	0	0	24783,5	0,450649	974	54
10	1773	397211	133342	25633,1	56147,3	68480,9	66293,5	22586,3	0	0	24727,7	0,416808	1034	52
11	1773	399893	135163	24836,9	56297,6	68828,7	66293,5	22106,2	0	0	26367,4	0,41286	1041	52

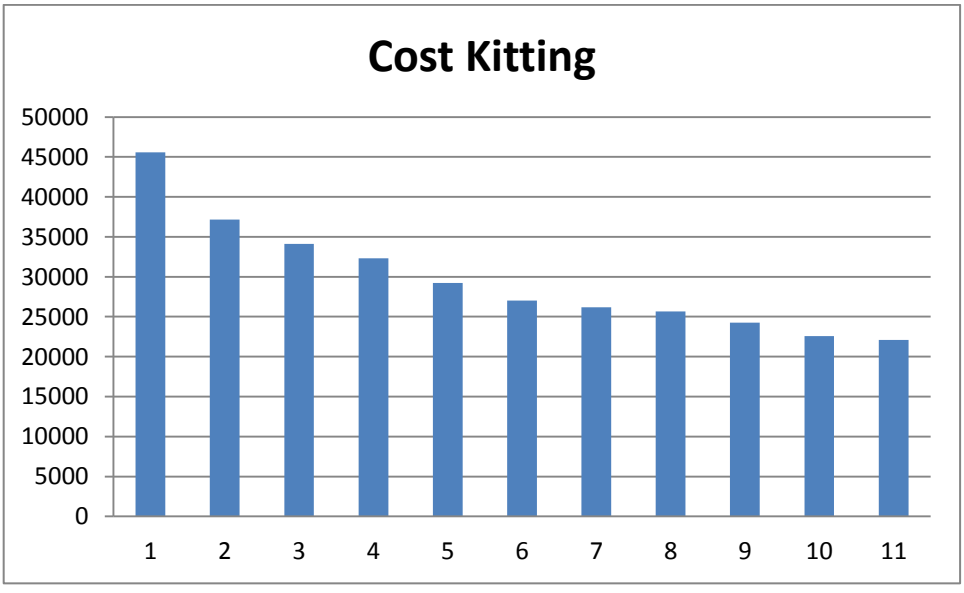

Total Cost
410000
400000
390000
380000
370000
360000
350000
340000
330000
320000
310000
1
2
3
4
5
6
7
8
9
10
11

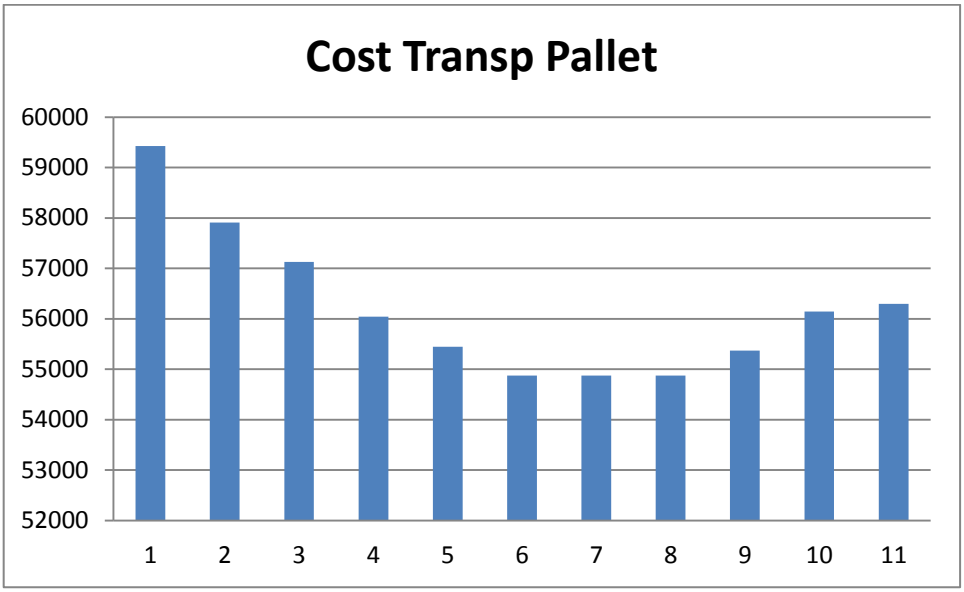

% of Parts Kitted
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
1
2
3
4
5
6
7
8
9
10
11

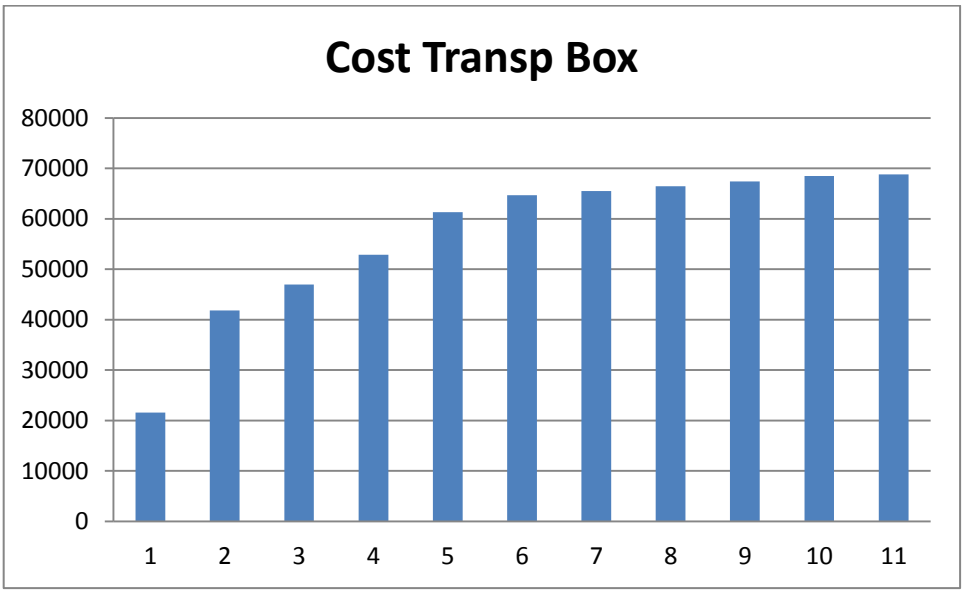

Number of Kits
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11

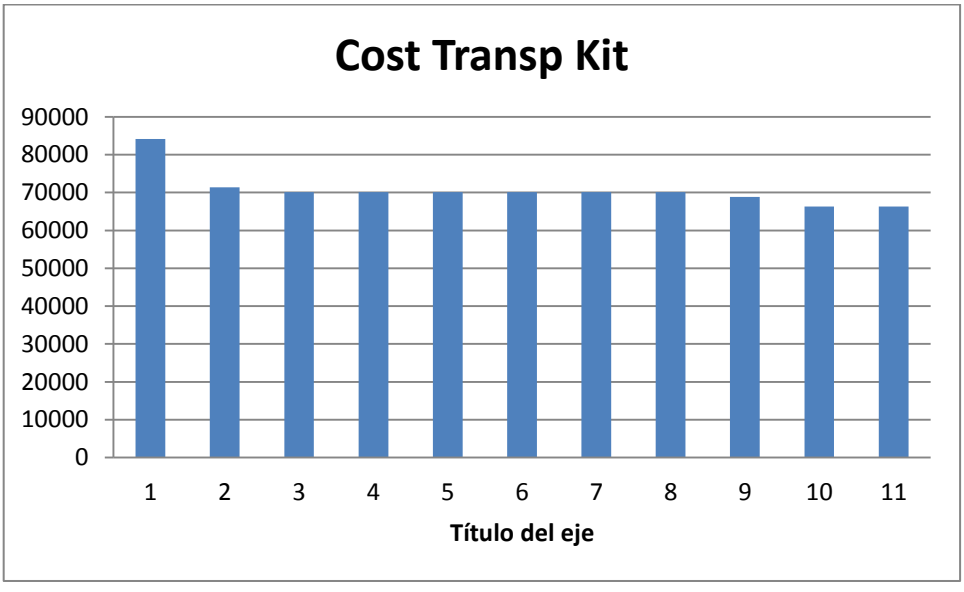

Cost Pick Bulk
160000
140000
120000
100000
80000
60000
40000
20000
0
1
2
3
4
5
6
7
8
9
10
11

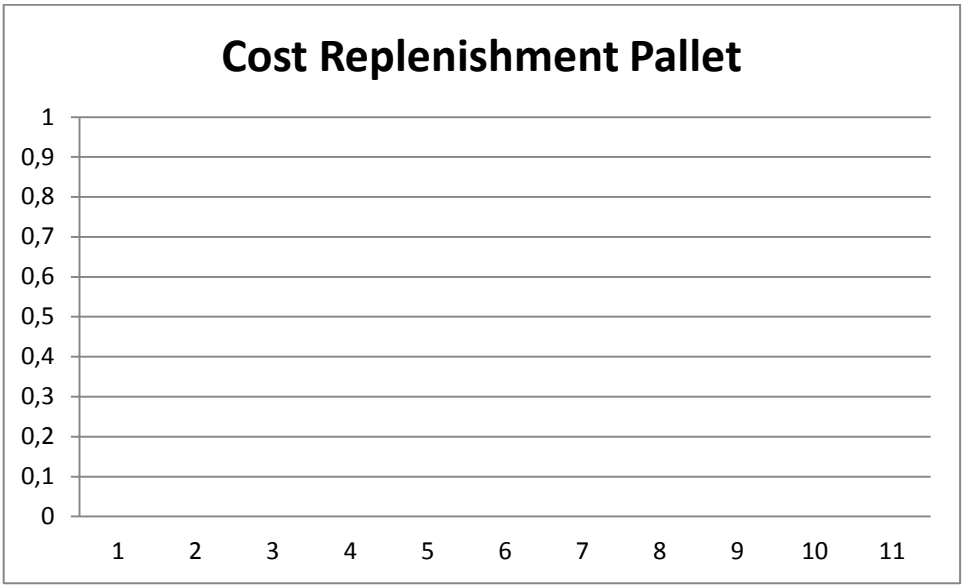

Cost Pick Kit
60000
50000
40000
30000
20000
10000
0
1
2
3
4
5
6
7
8
9
10
11

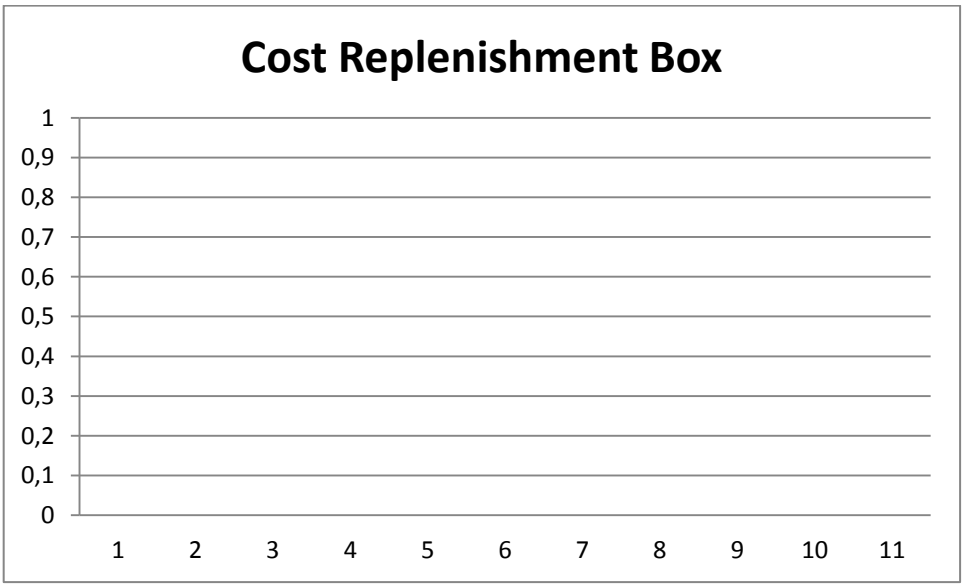

Cost Kitting
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
1
2
3
4
5
6
7
8
9
10
11

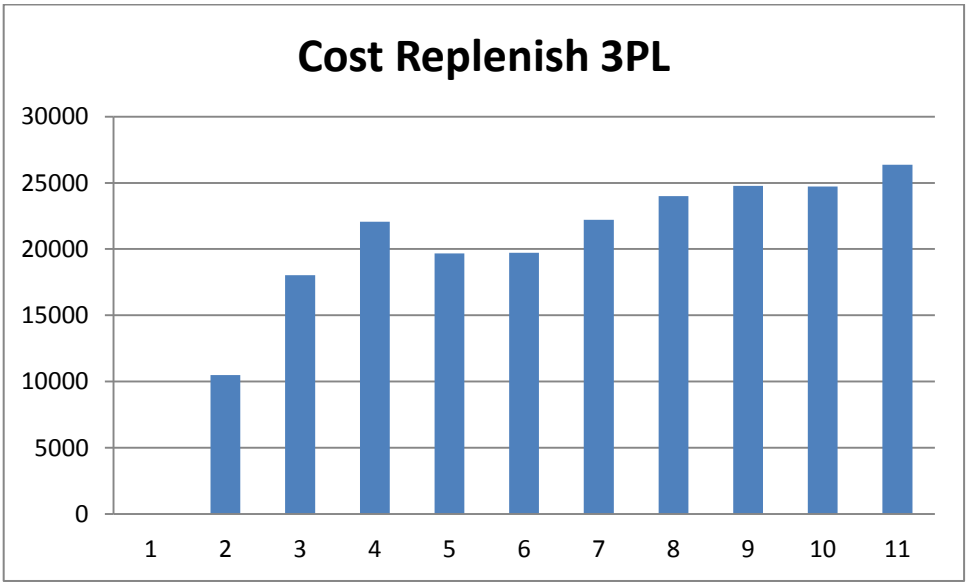

Cost Transp Pallet
60000
59000
58000
57000
56000
55000
54000
53000
52000
1
2
3
4
5
6
7
8
9
10
11


Cost Transp Box
80000
70000
60000
50000
40000
30000
20000
10000
0
1
2
3
4
5
6
7
8
9
10
11


Cost Transp Kit
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
1
2
3
4
5
6
7
8
9
10
11
Título del eje


Cost Replenishment Pallet
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
1 2 3 4 5 6 7 8 9 10 11


Cost Replenishment Box
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
1 2 3 4 5 6 7 8 9 10 11


Cost Replenish 3PL
30000
25000
20000
15000
10000
5000
0
1 2 3 4 5 6 7 8 9 10 11

2.5 New forklift equipment

TEMPLATE

LOWER VALUE	UPPER VALUE	STEP VALUE	units	# of results	# total results
OPERARI_COST_lower	OPERARI_COST_upper	OPERARI_COST_step			21
30	30	10	€/h	1	
OPERARI_COST_LOGISTIC_lower	OPERARI_COST_LOGISTIC_upper	OPERARI_COST_LOGISTIC_step			
30	30	1	€/h	1	
MAXIMUM_WEIGHT_lower	MAXIMUM_WEIGHT_upper	MAXIMUM_WEIGHT_step			
30	30	2	Kg	1	
MILK_RUN_TOUR_KIT_lower	MILK_RUN_TOUR_KIT_upper	MILK_RUN_TOUR_KIT_step			
1640	1640	100	m	1	
MILK_RUN_TOUR_BOX_lower	MILK_RUN_TOUR_BOX_upper	MILK_RUN_TOUR_BOX_step			
1640	1640	100	m	1	
SEARCH_TIME_KIT_lower	SEARCH_TIME_KIT_upper	SEARCH_TIME_KIT_step			
1,08	1,08	0,01	s	1	
SEARCH_TIME_BULK_lower	SEARCH_TIME_BULK_upper	SEARCH_TIME_BULK_step			
1,08	1,08	0,01	s	1	
BATCH_SIZE_lower	BATCH_SIZE_upper	BATCH_SIZE_step			
5	5	4	kit	1	
LENGTH_FACTOR_lower	LENGTH_FACTOR_upper	LENGTH_FACTOR_step			
1	1	0,1	-	1	
TRANSPORT_VELOCITY_BOX_lower	TRANSPORT_VELOCITY_BOX_upper	TRANSPORT_VELOCITY_BOX_step			
2412	2412	50	m/h	1	
TRANSPORT_VELOCITY_PALLET_lower	TRANSPORT_VELOCITY_PALLET_upper	TRANSPORT_VELOCITY_PALLET_step			
2880	3880	50	m/h	21	
TRANSPORT_VELOCITY_KIT_lower	TRANSPORT_VELOCITY_KIT_upper	TRANSPORT_VELOCITY_KIT_step			
2412	2412	50	m/h	1	
CAPACITY_MRT_BOX_lower	CAPACITY_MRT_BOX_upper	CAPACITY_MRT_BOX_step			
60	60	10	box	1	
CAPACITY_MRT_KIT_lower	CAPACITY_MRT_KIT_upper	CAPACITY_MRT_KIT_step			
70	70	10	kit	1	
CONSTANT_REPLENISH_BOX_lower	CONSTANT_REPLENISH_BOX_upper	CONSTANT_REPLENISH_BOX_step			
0,2	0,2	0,2	€	1	
CONSTANT_REPLENISH_PALLET_lower	CONSTANT_REPLENISH_PALLET_upper	CONSTANT_REPLENISH_PALLET_step			
1,2	1,2	0,6	€	1	
VOLUME_FACTOR_lower	VOLUME_FACTOR_upper	VOLUME_FACTOR_step			
1	1	0,1	-	1	
DISTANCE_PALLET_FACTOR_lower	DISTANCE_PALLET_FACTOR_upper	DISTANCE_PALLET_FACTOR_step			
1	1	0,3	-	1	
CONSTANT_REPLENISH_3PL_lower	CONSTANT_REPLENISH_3PL_upper	CONSTANT_REPLENISH_3PL_step			
0	0	0,1		1	

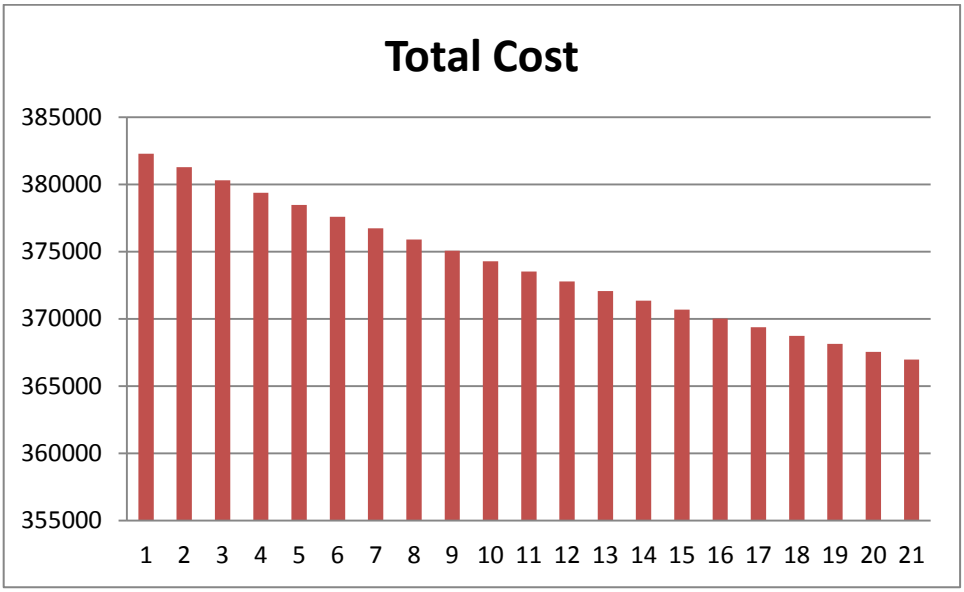
Parameter's values combinations

Obtain Combinations

#	OC	OCL	w^k	D^k	D^b	τ^k	τ^{bulk}	B^k	L^{fact}	V^b	V^p	V^k	A^b	A^k	R^b	R^p	V^{fact}	Dp^{fact}	R^{3PL}
Number of result	Operari Cost	Operari Cost Logistic	Maximum weight	Milk Run Tour Kit	Milk Run Tour Box	Search Time Kit	Search Time Bulk	Batch Size	Length Factor	Transport Velocity Box	Transport Velocity Pallet	Transport Velocity Kit	Capacity MRT Box	Capacity MRT Kit	Constant Replenish Box	Constant Replenish Pallet	Volume Factor	Distance Pallet Factor	Constant Replenish 3PL
1	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
2	30	30	30	1640	1640	1,08	1,08	5	1	2412	2930	2412	60	70	0,2	1,2	1	1	0
3	30	30	30	1640	1640	1,08	1,08	5	1	2412	2980	2412	60	70	0,2	1,2	1	1	0
4	30	30	30	1640	1640	1,08	1,08	5	1	2412	3030	2412	60	70	0,2	1,2	1	1	0
5	30	30	30	1640	1640	1,08	1,08	5	1	2412	3080	2412	60	70	0,2	1,2	1	1	0
6	30	30	30	1640	1640	1,08	1,08	5	1	2412	3130	2412	60	70	0,2	1,2	1	1	0
7	30	30	30	1640	1640	1,08	1,08	5	1	2412	3180	2412	60	70	0,2	1,2	1	1	0
8	30	30	30	1640	1640	1,08	1,08	5	1	2412	3230	2412	60	70	0,2	1,2	1	1	0
9	30	30	30	1640	1640	1,08	1,08	5	1	2412	3280	2412	60	70	0,2	1,2	1	1	0
10	30	30	30	1640	1640	1,08	1,08	5	1	2412	3330	2412	60	70	0,2	1,2	1	1	0
11	30	30	30	1640	1640	1,08	1,08	5	1	2412	3380	2412	60	70	0,2	1,2	1	1	0
12	30	30	30	1640	1640	1,08	1,08	5	1	2412	3430	2412	60	70	0,2	1,2	1	1	0
13	30	30	30	1640	1640	1,08	1,08	5	1	2412	3480	2412	60	70	0,2	1,2	1	1	0
14	30	30	30	1640	1640	1,08	1,08	5	1	2412	3530	2412	60	70	0,2	1,2	1	1	0
15	30	30	30	1640	1640	1,08	1,08	5	1	2412	3580	2412	60	70	0,2	1,2	1	1	0
16	30	30	30	1640	1640	1,08	1,08	5	1	2412	3630	2412	60	70	0,2	1,2	1	1	0
17	30	30	30	1640	1640	1,08	1,08	5	1	2412	3680	2412	60	70	0,2	1,2	1	1	0
18	30	30	30	1640	1640	1,08	1,08	5	1	2412	3730	2412	60	70	0,2	1,2	1	1	0
19	30	30	30	1640	1640	1,08	1,08	5	1	2412	3780	2412	60	70	0,2	1,2	1	1	0
20	30	30	30	1640	1640	1,08	1,08	5	1	2412	3830	2412	60	70	0,2	1,2	1	1	0
21	30	30	30	1640	1640	1,08	1,08	5	1	2412	3880	2412	60	70	0,2	1,2	1	1	0

TABLE OF RESULTS

Num.	Num of parts	Total Cost	Cost pick bulk	Cost pick kit	Cost transp pal	Cost transp box	Cost transp kit	Cost of kitting	Cost Repl Pal	Cost Repl box	Cost repl 3PL	Percentage of parts kitted	Number of parts bulked	Number of kits used
Num.	card(COMBI) =	Total_Cost =	Cost_pick_bulk =	Cost_pick_kit =	Cost_Transp_pal =	Cost_Transp_box =	Cost_Transp_kit =	Cost_Kitting =	Cost_Repl_pal =	Cost_Repl_box =	Cost_Repl_3pl =	(sum{(i,s) in COMBI} (1 - x[i,	sum{(i,s) in COMBI} x[i,s]	sum{s in S} K[s] =
1	1773	382271	102889	38753,7	58569,4	44045,8	70118,2	53045,1	6066,66	8783,13	0	0,556684	786	55
2	1773	381271	102889	38753,7	57569,9	44045,8	70118,2	53045,1	6066,66	8783,13	0	0,556684	786	55
3	1773	380306	102889	38753,7	56603,9	44045,8	70118,2	53045,1	6066,66	8783,13	0	0,556684	786	55
4	1773	379371	103026	38683,7	55785,4	44003	70118,2	52949,9	6009,26	8795,73	0	0,559504	781	55
5	1773	378465	103032	38683,7	55027,8	43860,2	70118,2	52949,9	5955,65	8837,73	0	0,560068	780	55
6	1773	377586	103032	38683,7	54148,8	43860,2	70118,2	52949,9	5955,65	8837,73	0	0,560068	780	55
7	1773	376726	104185	38605	54136,1	43860,2	68843,3	52550,9	5707,38	8837,73	0	0,55894	782	54
8	1773	375888	104185	38605	53298,1	43860,2	68843,3	52550,9	5707,38	8837,73	0	0,55894	782	54
9	1773	375075	104185	38605	52485,6	43860,2	68843,3	52550,9	5707,38	8837,73	0	0,55894	782	54
10	1773	374287	104185	38605	51697,5	43860,2	68843,3	52550,9	5707,38	8837,73	0	0,55894	782	54
11	1773	373522	104185	38605	50932,8	43860,2	68843,3	52550,9	5707,38	8837,73	0	0,55894	782	54
12	1773	372780	104185	38605	50190,3	43860,2	68843,3	52550,9	5707,38	8837,73	0	0,55894	782	54
13	1773	372059	104185	38605	49469,2	43860,2	68843,3	52550,9	5707,38	8837,73	0	0,55894	782	54
14	1773	371358	104185	38605	48768,5	43860,2	68843,3	52550,9	5707,38	8837,73	0	0,55894	782	54
15	1773	370677	104185	38605	48087,4	43860,2	68843,3	52550,9	5707,38	8837,73	0	0,55894	782	54
16	1773	370015	104185	38605	47425	43860,2	68843,3	52550,9	5707,38	8837,73	0	0,55894	782	54
17	1773	369370	104185	38605	46780,6	43860,2	68843,3	52550,9	5707,38	8837,73	0	0,55894	782	54
18	1773	368743	104185	38605	46153,5	43860,2	68843,3	52550,9	5707,38	8837,73	0	0,55894	782	54
19	1773	368133	104185	38605	45543	43860,2	68843,3	52550,9	5707,38	8837,73	0	0,55894	782	54
20	1773	367538	104185	38605	44948,5	43860,2	68843,3	52550,9	5707,38	8837,73	0	0,55894	782	54
21	1773	366959	104185	38605	44369,3	43860,2	68843,3	52550,9	5707,38	8837,73	0	0,55894	782	54


Total Cost
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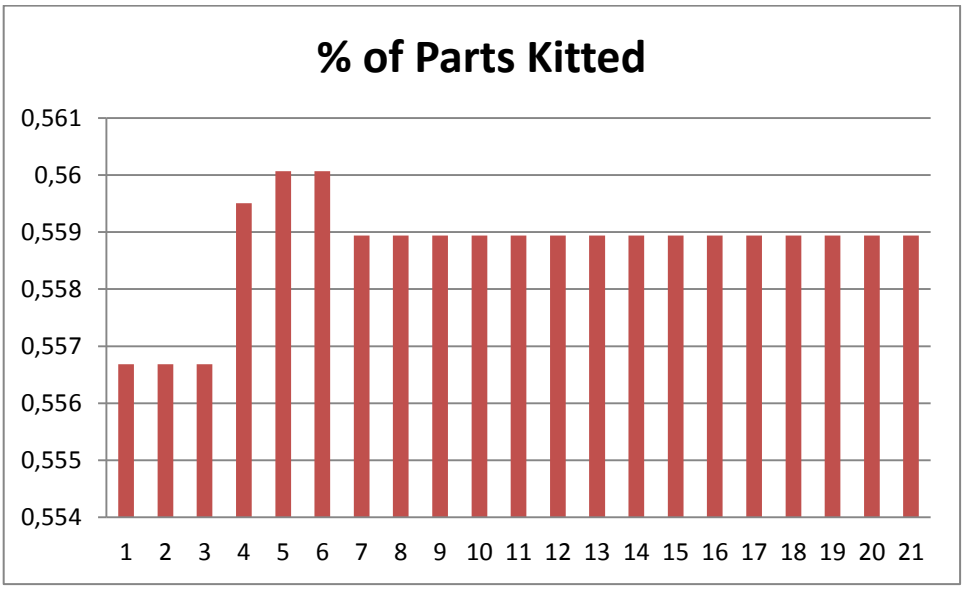
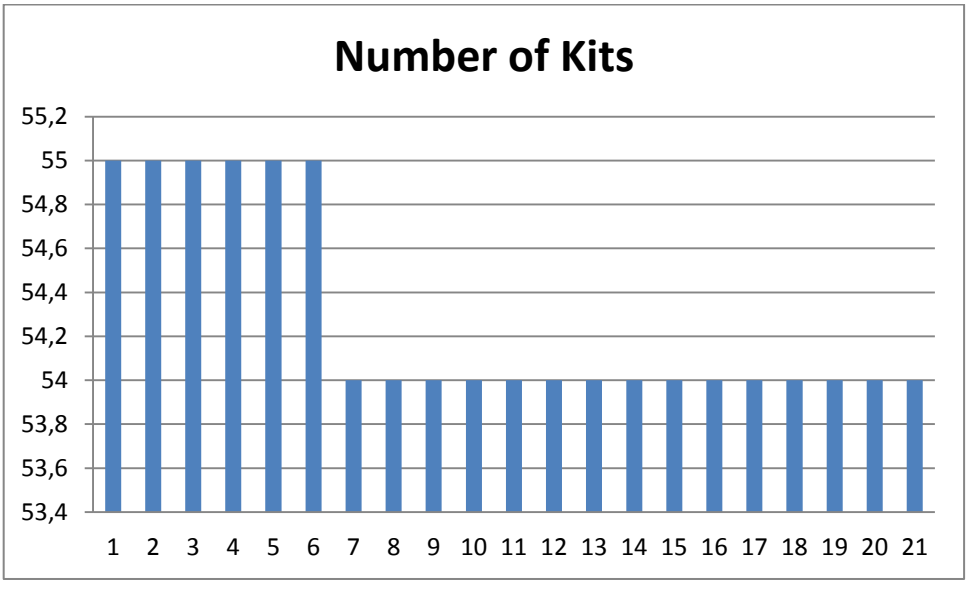
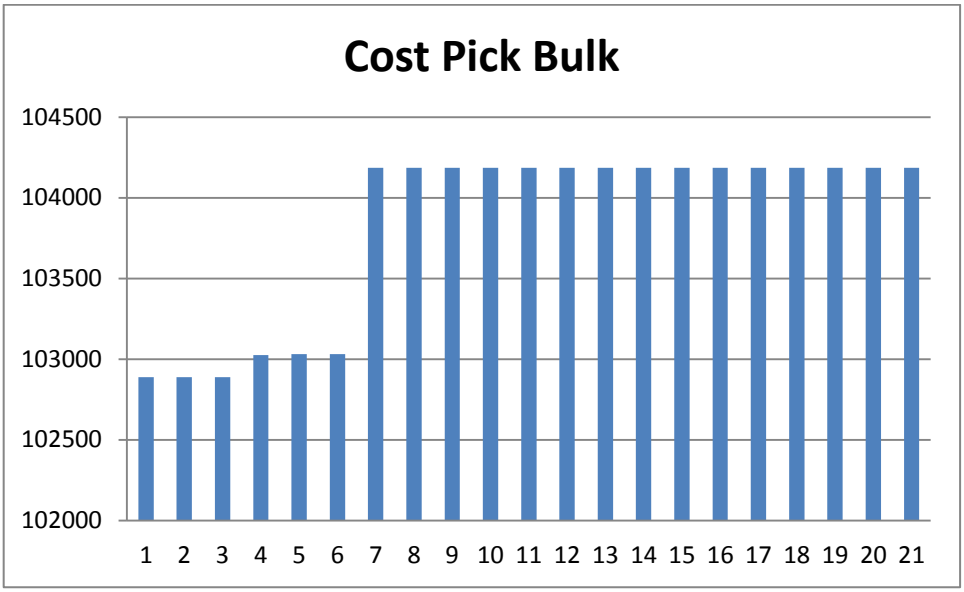
380000
375000
370000
365000
360000
355000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21


% of Parts Kitted
0,561
0,56
0,559
0,558
0,557
0,556
0,555
0,554
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21


Number of Kits
55,2
55
54,8
54,6
54,4
54,2
54
53,8
53,6
53,4
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21


Cost Pick Bulk
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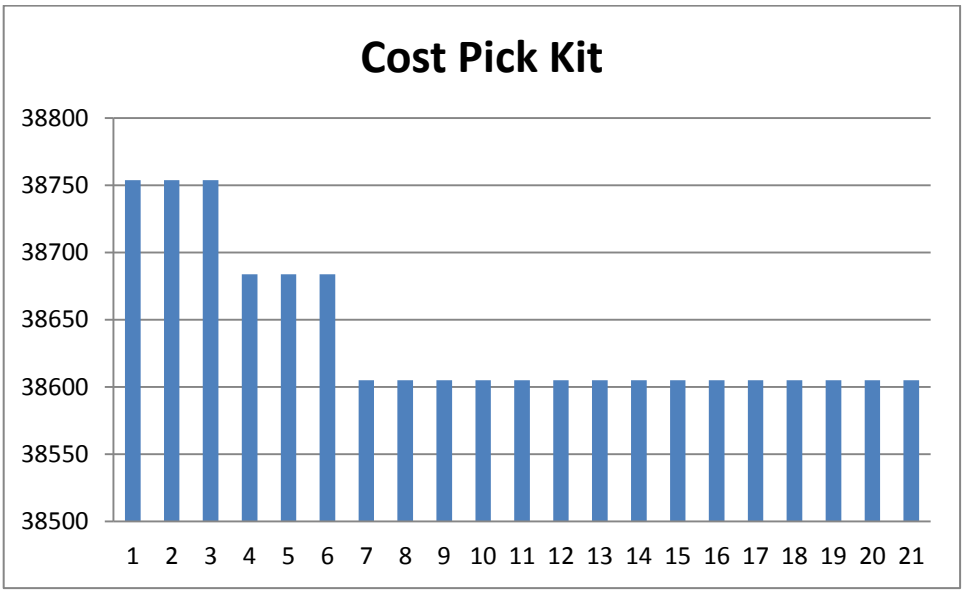
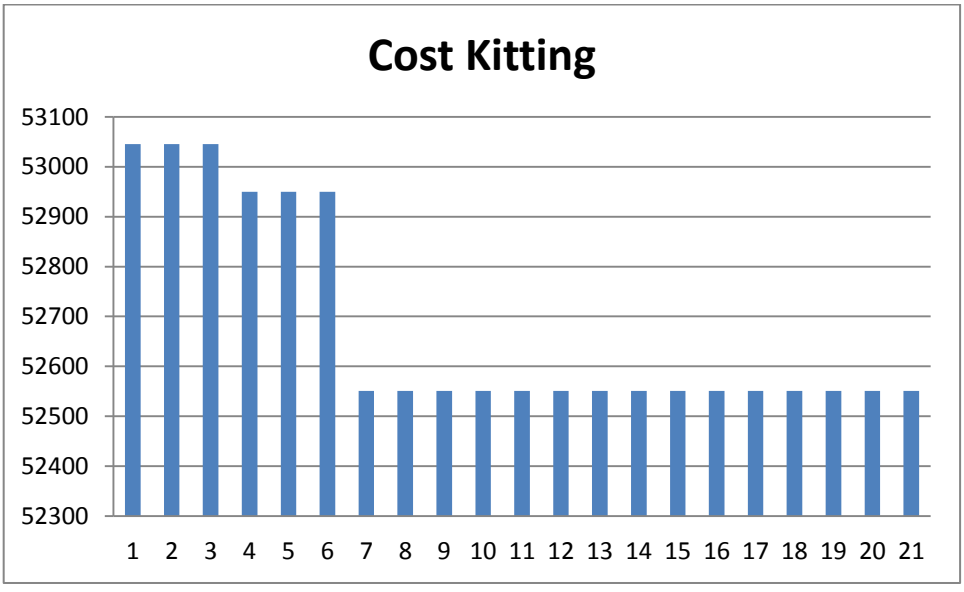
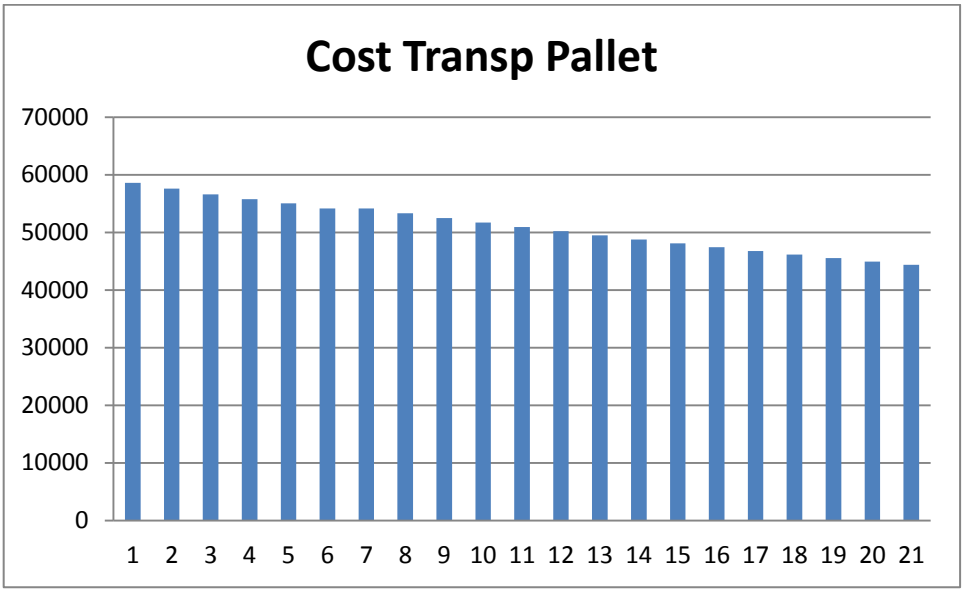
104000
103500
103000
102500
102000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21


Cost Pick Kit
38800
38750
38700
38650
38600
38550
38500
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21


Cost Kitting
53100
53000
52900
52800
52700
52600
52500
52400
52300
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21


Cost Transp Pallet
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60000
50000
40000
30000
20000
10000
0
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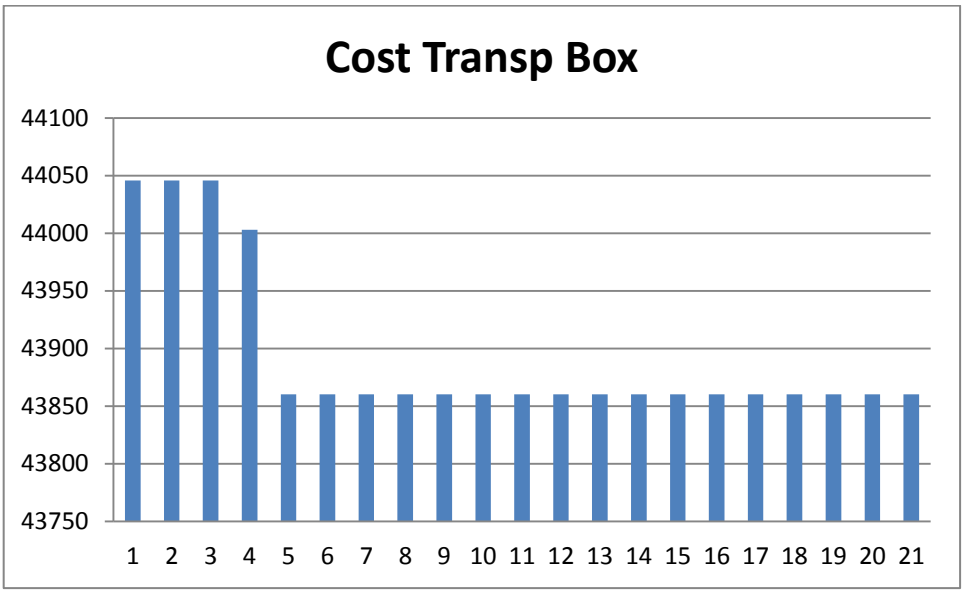
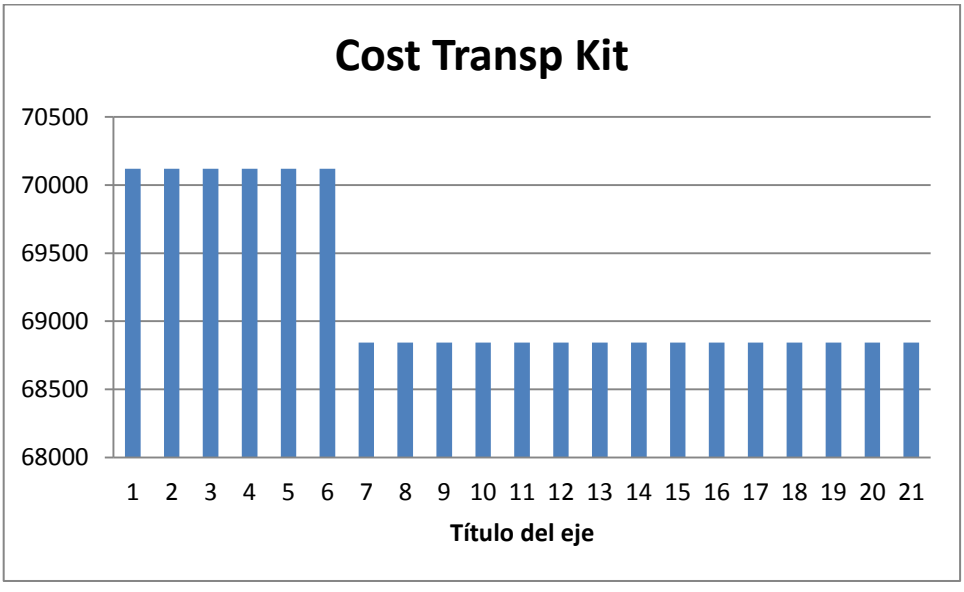
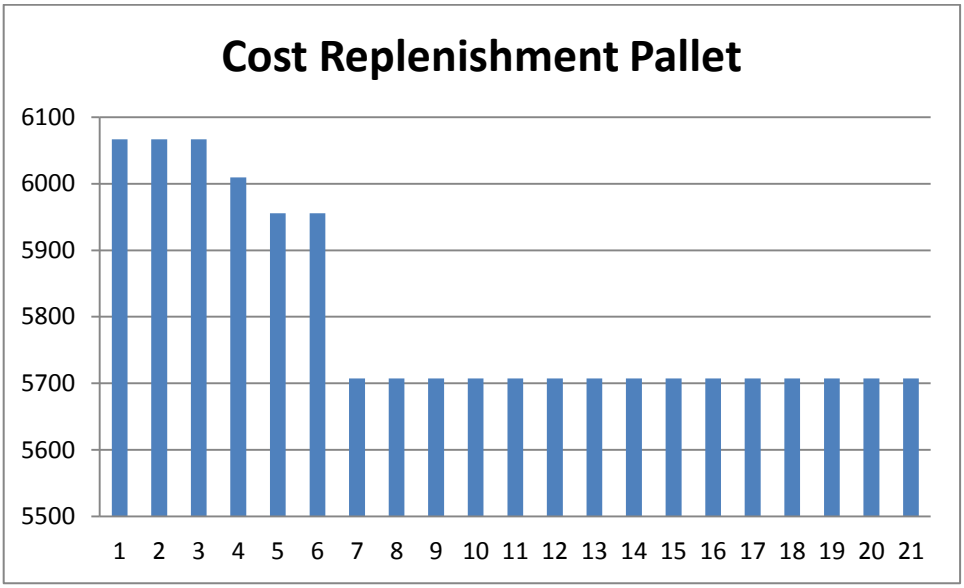
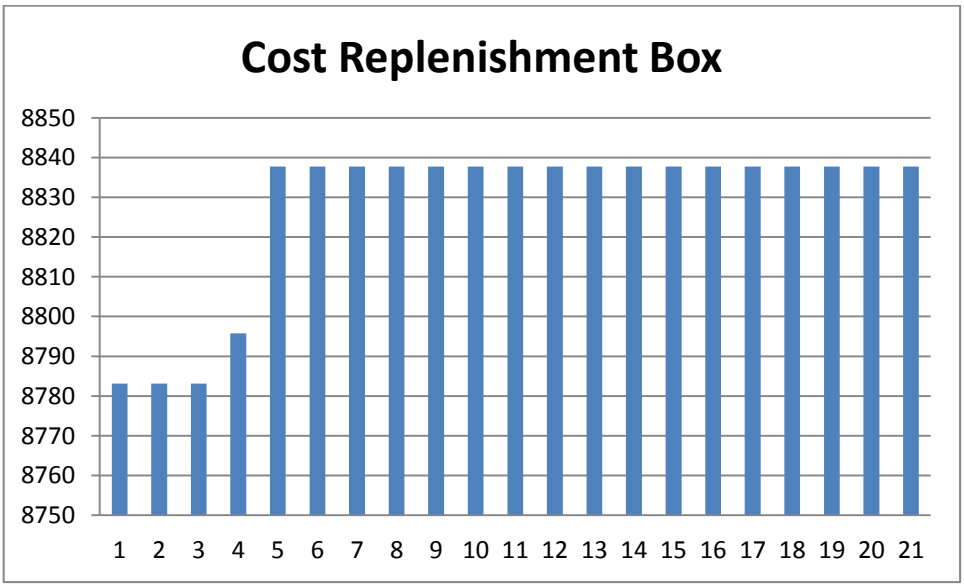
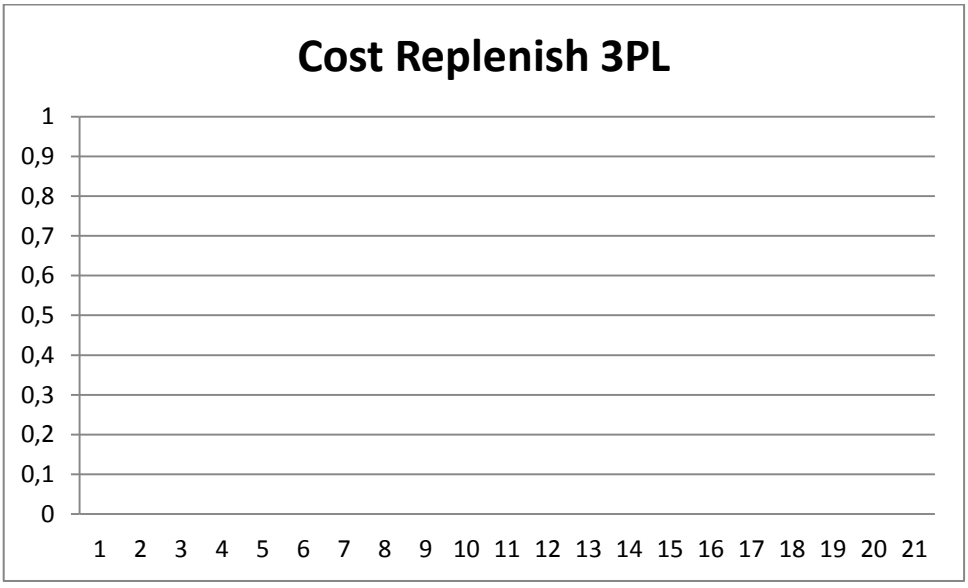

Cost Transp Box
44100
44050
44000
43950
43900
43850
43800
43750
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21


Cost Transp Kit
70500
70000
69500
69000
68500
68000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Título del eje


Cost Replenishment Pallet
6100
6000
5900
5800
5700
5600
5500
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21


Cost Replenishment Box
8850
8840
8830
8820
8810
8800
8790
8780
8770
8760
8750
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21


Cost Replenish 3PL
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

2.6 New tugger train for kits

TEMPLATE

LOWER VALUE	UPPER VALUE	STEP VALUE	units	# of results	# total results
OPERARI_COST_lower	OPERARI_COST_upper	OPERARI_COST_step			21
30	30	10	€/h	1	
OPERARI_COST_LOGISTIC_lower	OPERARI_COST_LOGISTIC_upper	OPERARI_COST_LOGISTIC_step			
30	30	1	€/h	1	
MAXIMUM_WEIGHT_lower	MAXIMUM_WEIGHT_upper	MAXIMUM_WEIGHT_step			
30	30	2	Kg	1	
MILK_RUN_TOUR_KIT_lower	MILK_RUN_TOUR_KIT_upper	MILK_RUN_TOUR_KIT_step			
1640	1640	100	m	1	
MILK_RUN_TOUR_BOX_lower	MILK_RUN_TOUR_BOX_upper	MILK_RUN_TOUR_BOX_step			
1640	1640	100	m	1	
SEARCH_TIME_KIT_lower	SEARCH_TIME_KIT_upper	SEARCH_TIME_KIT_step			
1,08	1,08	0,01	s	1	
SEARCH_TIME_BULK_lower	SEARCH_TIME_BULK_upper	SEARCH_TIME_BULK_step			
1,08	1,08	0,01	s	1	
BATCH_SIZE_lower	BATCH_SIZE_upper	BATCH_SIZE_step			
5	5	4	kit	1	
LENGTH_FACTOR_lower	LENGTH_FACTOR_upper	LENGTH_FACTOR_step			
1	1	0,1	-	1	
TRANSPORT_VELOCITY_BOX_lower	TRANSPORT_VELOCITY_BOX_upper	TRANSPORT_VELOCITY_BOX_step			
2412	2412	50	m/h	1	
TRANSPORT_VELOCITY_PALLET_lower	TRANSPORT_VELOCITY_PALLET_upper	TRANSPORT_VELOCITY_PALLET_step			
2880	2880	50	m/h	1	
TRANSPORT_VELOCITY_KIT_lower	TRANSPORT_VELOCITY_KIT_upper	TRANSPORT_VELOCITY_KIT_step			
2412	3412	50	m/h	21	
CAPACITY_MRT_BOX_lower	CAPACITY_MRT_BOX_upper	CAPACITY_MRT_BOX_step			
60	60	10	box	1	
CAPACITY_MRT_KIT_lower	CAPACITY_MRT_KIT_upper	CAPACITY_MRT_KIT_step			
60	60	10	kit	1	
CONSTANT_REPLENISH_BOX_lower	CONSTANT_REPLENISH_BOX_upper	CONSTANT_REPLENISH_BOX_step			
0,2	0,2	0,2	€	1	
CONSTANT_REPLENISH_PALLET_lower	CONSTANT_REPLENISH_PALLET_upper	CONSTANT_REPLENISH_PALLET_step			
1,2	1,2	0,6	€	1	
VOLUME_FACTOR_lower	VOLUME_FACTOR_upper	VOLUME_FACTOR_step			
1	1	0,1	-	1	
DISTANCE_PALLET_FACTOR_lower	DISTANCE_PALLET_FACTOR_upper	DISTANCE_PALLET_FACTOR_step			
1	1	0,3	-	1	
CONSTANT_REPLENISH_3PL_lower	CONSTANT_REPLENISH_3PL_upper	CONSTANT_REPLENISH_3PL_step			
0	0	0,1		1	

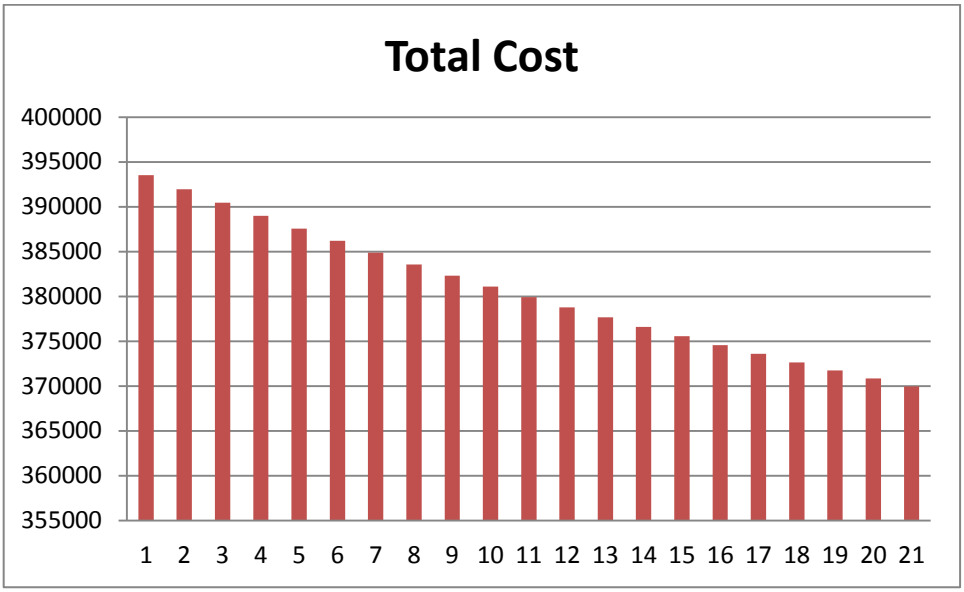
Parameter's values combinations

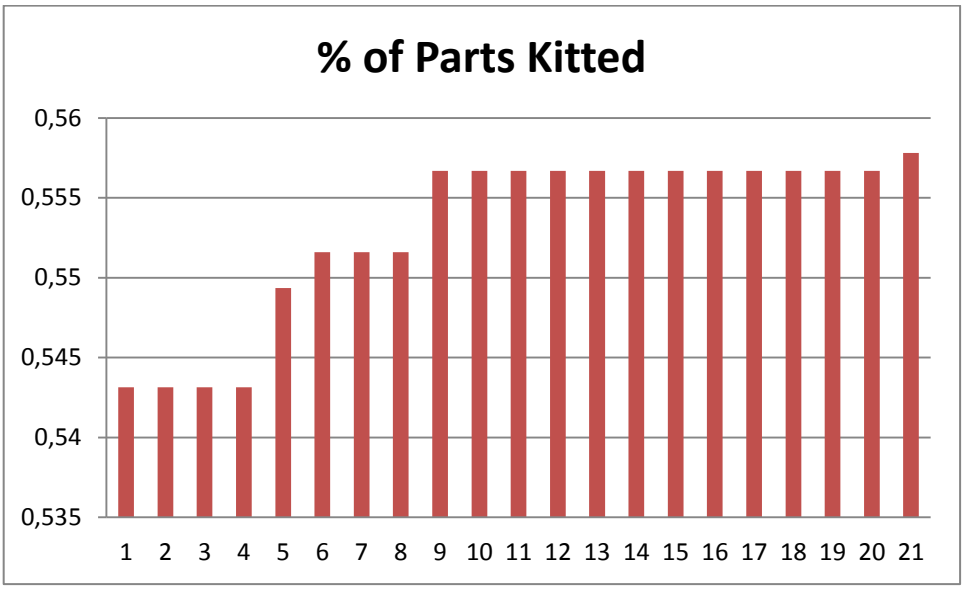
Obtain Combinations

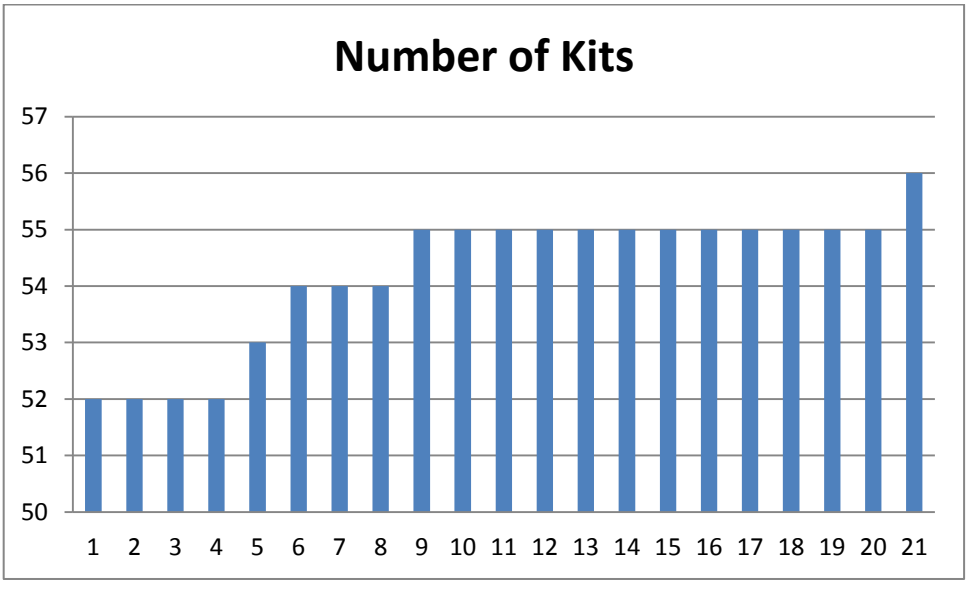
#	OC	OCL	w^k	D^k	D^b	τ^k	τ^{bulk}	B^k	L^{fact}	V^b	V^p	V^k	A^b	A^k	R^b	R^p	V^{fact}	Dp^{fact}	R^{3PL}
Number of result	Operari Cost	Operari Cost Logistic	Maximum weight	Milk Run Tour Kit	Milk Run Tour Box	Search Time Kit	Search Time Bulk	Batch Size	Length Factor	Transport Velocity Box	Transport Velocity Pallet	Transport Velocity Kit	Capacity MRT Box	Capacity MRT Kit	Constant Replenish Box	Constant Replenish Pallet	Volume Factor	Distance Pallet Factor	Constant Replenish 3PL
1	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	2412	60	60	0,2	1,2	1	1	0
2	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	2462	60	60	0,2	1,2	1	1	0
3	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	2512	60	60	0,2	1,2	1	1	0
4	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	2562	60	60	0,2	1,2	1	1	0
5	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	2612	60	60	0,2	1,2	1	1	0
6	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	2662	60	60	0,2	1,2	1	1	0
7	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	2712	60	60	0,2	1,2	1	1	0
8	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	2762	60	60	0,2	1,2	1	1	0
9	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	2812	60	60	0,2	1,2	1	1	0
10	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	2862	60	60	0,2	1,2	1	1	0
11	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	2912	60	60	0,2	1,2	1	1	0
12	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	2962	60	60	0,2	1,2	1	1	0
13	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	3012	60	60	0,2	1,2	1	1	0
14	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	3062	60	60	0,2	1,2	1	1	0
15	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	3112	60	60	0,2	1,2	1	1	0
16	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	3162	60	60	0,2	1,2	1	1	0
17	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	3212	60	60	0,2	1,2	1	1	0
18	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	3262	60	60	0,2	1,2	1	1	0
19	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	3312	60	60	0,2	1,2	1	1	0
20	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	3362	60	60	0,2	1,2	1	1	0
21	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	3412	60	60	0,2	1,2	1	1	0

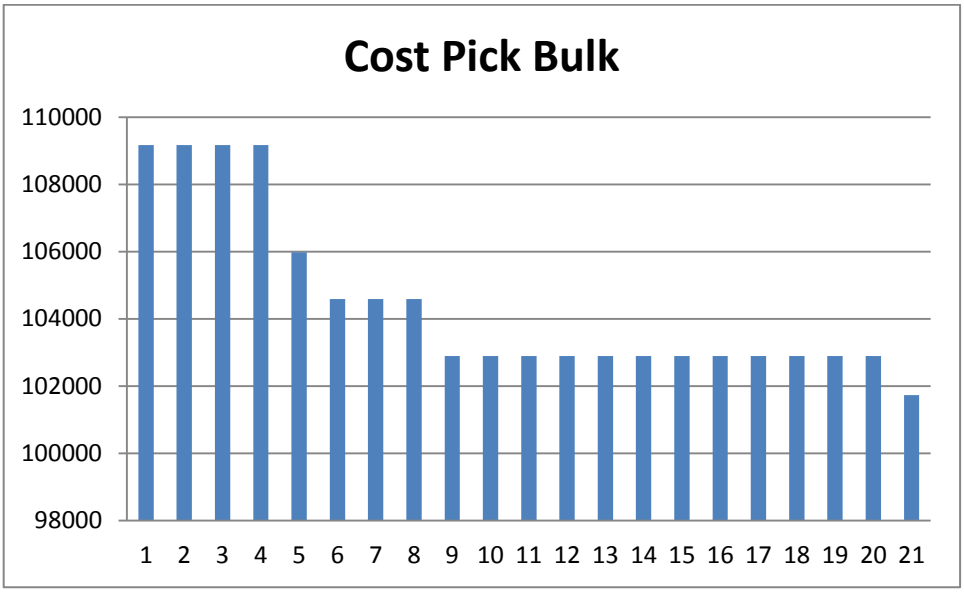
TABLE OF RESULTS

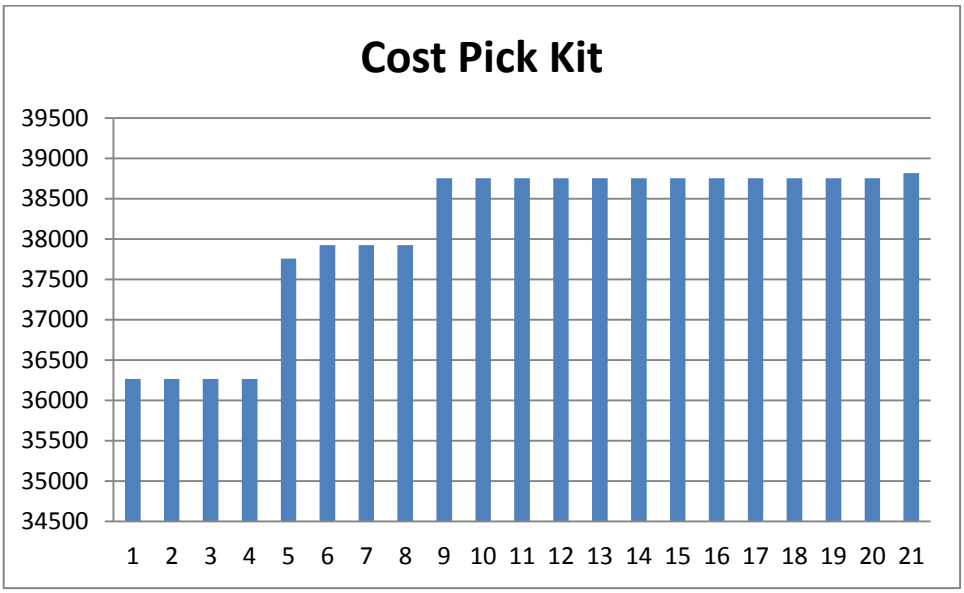
Num.	Num of parts	Total Cost	Cost pick bulk	Cost pick kit	Cost transp pal	Cost transp box	Cost transp kit	Cost of kitting	Cost Repl Pal	Cost Repl box	Cost repl 3PL	Percentage of parts kitted	Number of parts bulked	Number of kits used
Num.	card(COMBI) =	Total_Cost =	Cost_pick_bulk =	Cost_pick_kit =	Cost_Transp_pal =	Cost_Transp_box =	Cost_Transp_kit =	Cost_Kitting =	Cost_Repl_pal =	Cost_Repl_box =	Cost_Repl_3pl =	(sum{(i,s) in COMBI} (1 - x[i,	sum{(i,s) in COMBI} x[i,s]	sum{s in S} K[s] =
1	1773	393520	109165	36264,4	59615,1	47386,3	77342,5	50176,1	5770,1	7800,57	0	0,543147	810	52
2	1773	391949	109165	36264,4	59615,1	47386,3	75771,7	50176,1	5770,1	7800,57	0	0,543147	810	52
3	1773	390441	109165	36264,4	59615,1	47386,3	74263,5	50176,1	5770,1	7800,57	0	0,543147	810	52
4	1773	388991	109165	36264,4	59615,1	47386,3	72814,2	50176,1	5770,1	7800,57	0	0,543147	810	52
5	1773	387576	105976	37756,2	59411,5	46663,6	72793,8	51104,7	5857,6	8013,13	0	0,549351	799	53
6	1773	386208	104591	37922,5	58541,8	46663,6	72774,2	51622,7	6079,26	8013,13	0	0,551607	795	54
7	1773	384867	104591	37922,5	58541,8	46663,6	71432,5	51622,7	6079,26	8013,13	0	0,551607	795	54
8	1773	383574	104591	37922,5	58541,8	46663,6	70139,4	51622,7	6079,26	8013,13	0	0,551607	795	54
9	1773	382321	102889	38753,7	58569,4	44045,8	70168	53045,1	6066,66	8783,13	0	0,556684	786	55
10	1773	381095	102889	38753,7	58569,4	44045,8	68942,2	53045,1	6066,66	8783,13	0	0,556684	786	55
11	1773	379911	102889	38753,7	58569,4	44045,8	67758,4	53045,1	6066,66	8783,13	0	0,556684	786	55
12	1773	378767	102889	38753,7	58569,4	44045,8	66614,6	53045,1	6066,66	8783,13	0	0,556684	786	55
13	1773	377662	102889	38753,7	58569,4	44045,8	65508,8	53045,1	6066,66	8783,13	0	0,556684	786	55
14	1773	376592	102889	38753,7	58569,4	44045,8	64439,1	53045,1	6066,66	8783,13	0	0,556684	786	55
15	1773	375557	102889	38753,7	58569,4	44045,8	63403,8	53045,1	6066,66	8783,13	0	0,556684	786	55
16	1773	374554	102889	38753,7	58569,4	44045,8	62401,2	53045,1	6066,66	8783,13	0	0,556684	786	55
17	1773	373583	102889	38753,7	58569,4	44045,8	61429,8	53045,1	6066,66	8783,13	0	0,556684	786	55
18	1773	372641	102889	38753,7	58569,4	44045,8	60488,2	53045,1	6066,66	8783,13	0	0,556684	786	55
19	1773	371728	102889	38753,7	58569,4	44045,8	59575	53045,1	6066,66	8783,13	0	0,556684	786	55
20	1773	370842	102889	38753,7	58569,4	44045,8	58689	53045,1	6066,66	8783,13	0	0,556684	786	55
21	1773	369967	101735	38815	57949,6	44093,4	58880,4	53420,3	6304,66	8769,13	0	0,557812	784	56

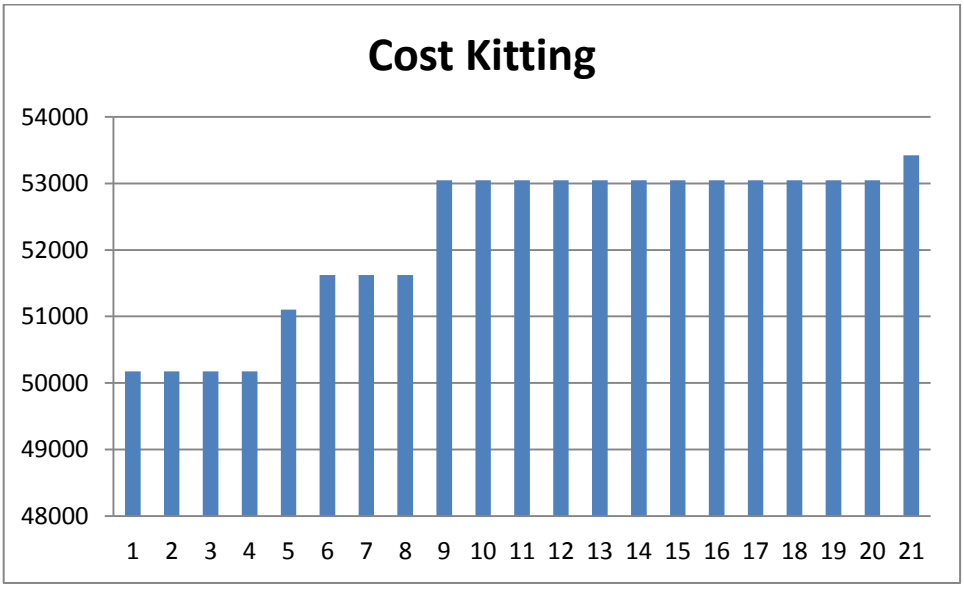

Total Cost
400000
395000
390000
385000
380000
375000
370000
365000
360000
355000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

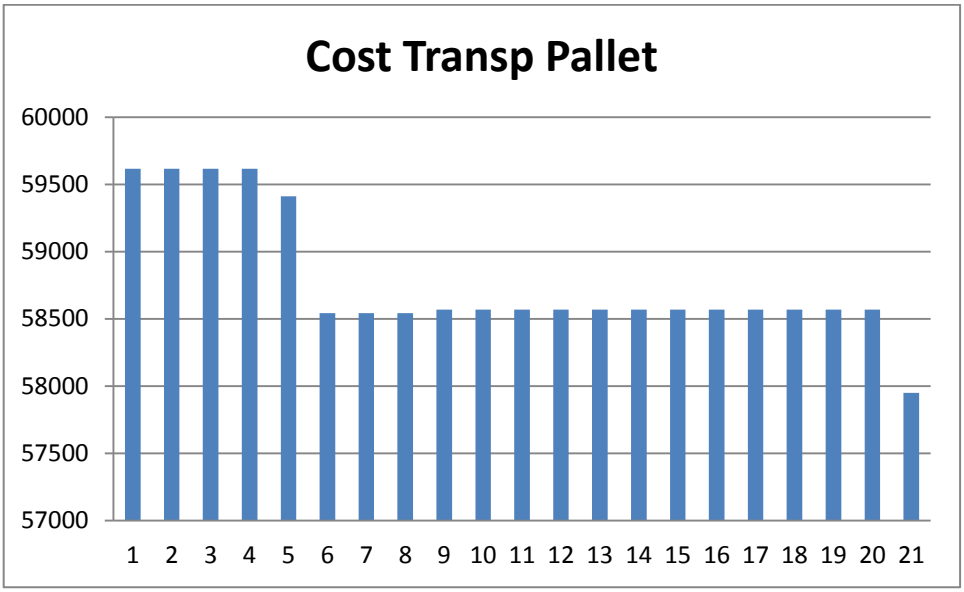

% of Parts Kitted
0,56
0,555
0,55
0,545
0,54
0,535
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

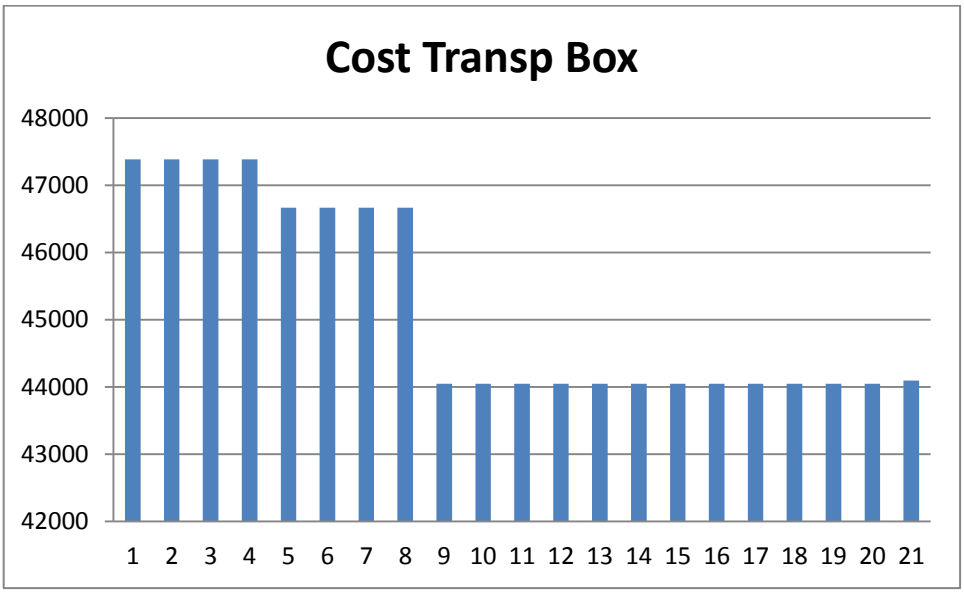

Number of Kits
57
56
55
54
53
52
51
50
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

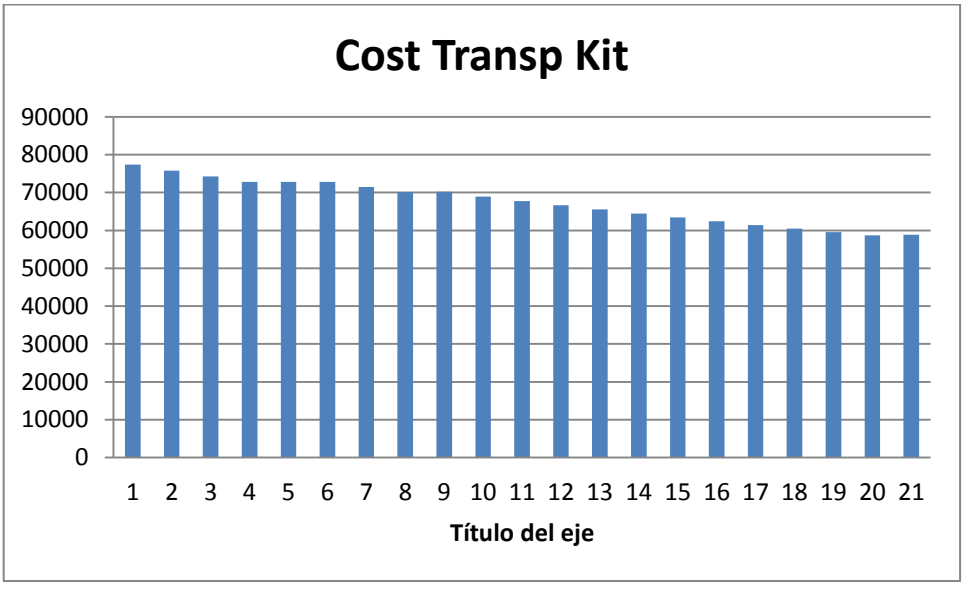

Cost Pick Bulk
110000
108000
106000
104000
102000
100000
98000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

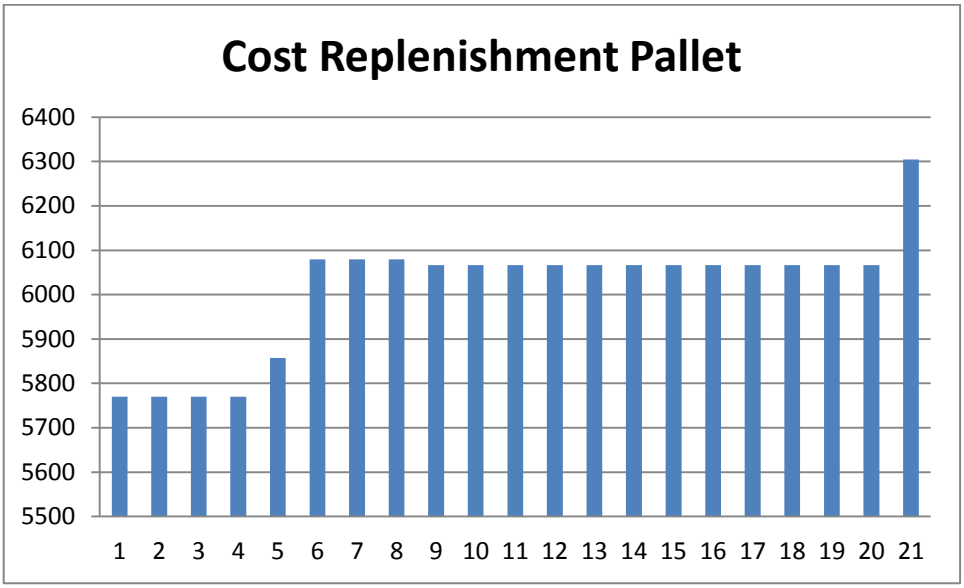

Cost Pick Kit
39500
39000
38500
38000
37500
37000
36500
36000
35500
35000
34500
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

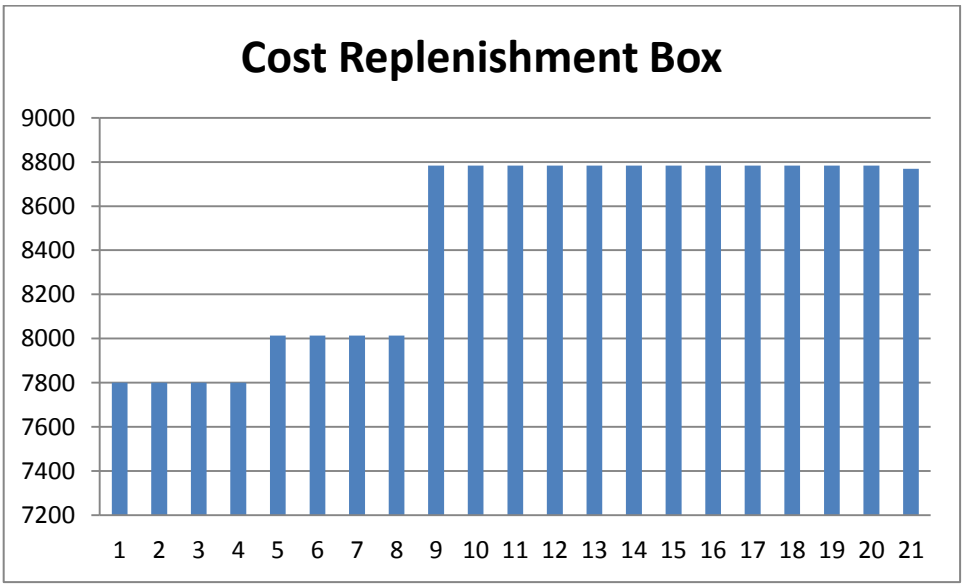

Cost Kitting
54000
53000
52000
51000
50000
49000
48000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

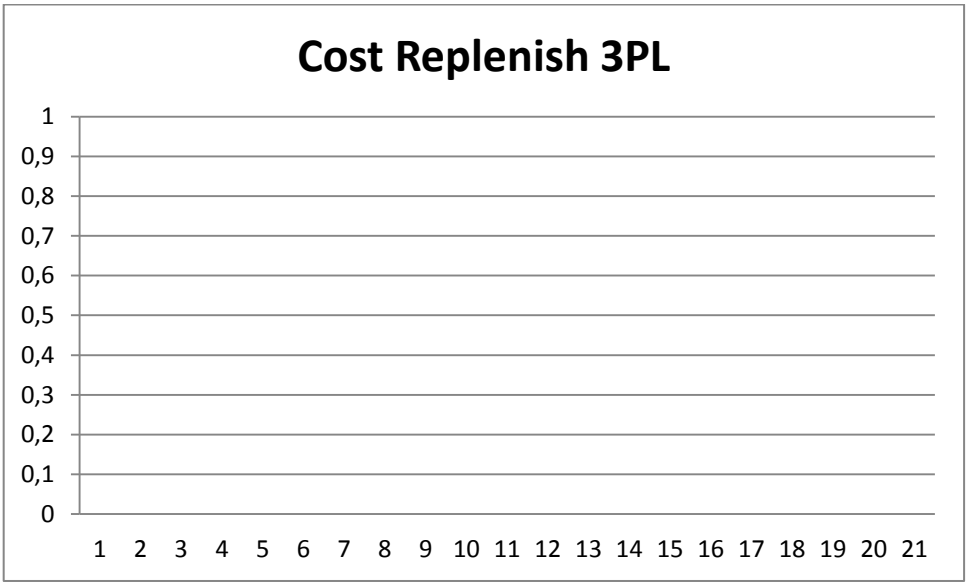

Cost Transp Pallet
60000
59500
59000
58500
58000
57500
57000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21


Cost Transp Box
48000
47000
46000
45000
44000
43000
42000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21


Cost Transp Kit
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Título del eje


Cost Replenishment Pallet
6400
6300
6200
6100
6000
5900
5800
5700
5600
5500
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21


Cost Replenishment Box
9000
8800
8600
8400
8200
8000
7800
7600
7400
7200
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21


Cost Replenish 3PL
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

2.7 Kit batch size

TEMPLATE					
LOWER VALUE	UPPER VALUE	STEP VALUE	units	# of results	# total results
OPERARI_COST_lower	OPERARI_COST_upper	OPERARI_COST_step			5
30	30	10	€/h	1	
OPERARI_COST_LOGISTIC_lower	OPERARI_COST_LOGISTIC_upper	OPERARI_COST_LOGISTIC_step			
30	30	1	€/h	1	
MAXIMUM_WEIGHT_lower	MAXIMUM_WEIGHT_upper	MAXIMUM_WEIGHT_step			
30	30	2	Kg	1	
MILK_RUN_TOUR_KIT_lower	MILK_RUN_TOUR_KIT_upper	MILK_RUN_TOUR_KIT_step			
1640	1640	100	m	1	
MILK_RUN_TOUR_BOX_lower	MILK_RUN_TOUR_BOX_upper	MILK_RUN_TOUR_BOX_step			
1640	1640	100	m	1	
SEARCH_TIME_KIT_lower	SEARCH_TIME_KIT_upper	SEARCH_TIME_KIT_step			
1,08	1,08	0,01	s	1	
SEARCH_TIME_BULK_lower	SEARCH_TIME_BULK_upper	SEARCH_TIME_BULK_step			
1,08	1,08	0,01	s	1	
BATCH_SIZE_lower	BATCH_SIZE_upper	BATCH_SIZE_step			
1	5	1	kit	5	
LENGTH_FACTOR_lower	LENGTH_FACTOR_upper	LENGTH_FACTOR_step			
1	1	0,1	-	1	
TRANSPORT_VELOCITY_BOX_lower	TRANSPORT_VELOCITY_BOX_upper	TRANSPORT_VELOCITY_BOX_step			
2412	2412	50	m/h	1	
TRANSPORT_VELOCITY_PALLET_lower	TRANSPORT_VELOCITY_PALLET_upper	TRANSPORT_VELOCITY_PALLET_step			
2880	2880	50	m/h	1	
TRANSPORT_VELOCITY_KIT_lower	TRANSPORT_VELOCITY_KIT_upper	TRANSPORT_VELOCITY_KIT_step			
2412	2412	50	m/h	1	
CAPACITY_MRT_BOX_lower	CAPACITY_MRT_BOX_upper	CAPACITY_MRT_BOX_step			
60	60	10	box	1	
CAPACITY_MRT_KIT_lower	CAPACITY_MRT_KIT_upper	CAPACITY_MRT_KIT_step			
70	70	10	kit	1	
CONSTANT_REPLENISH_BOX_lower	CONSTANT_REPLENISH_BOX_upper	CONSTANT_REPLENISH_BOX_step			
0,2	0,2	0,2	€	1	
CONSTANT_REPLENISH_PALLET_lower	CONSTANT_REPLENISH_PALLET_upper	CONSTANT_REPLENISH_PALLET_step			
1,2	1,2	0,6	€	1	
VOLUME_FACTOR_lower	VOLUME_FACTOR_upper	VOLUME_FACTOR_step			
1	1	0,1	-	1	
DISTANCE_PALLET_FACTOR_lower	DISTANCE_PALLET_FACTOR_upper	DISTANCE_PALLET_FACTOR_step			
1	1	0,3	-	1	
CONSTANT_REPLENISH_3PL_lower	CONSTANT_REPLENISH_3PL_upper	CONSTANT_REPLENISH_3PL_step			
0	0	0,1		1	

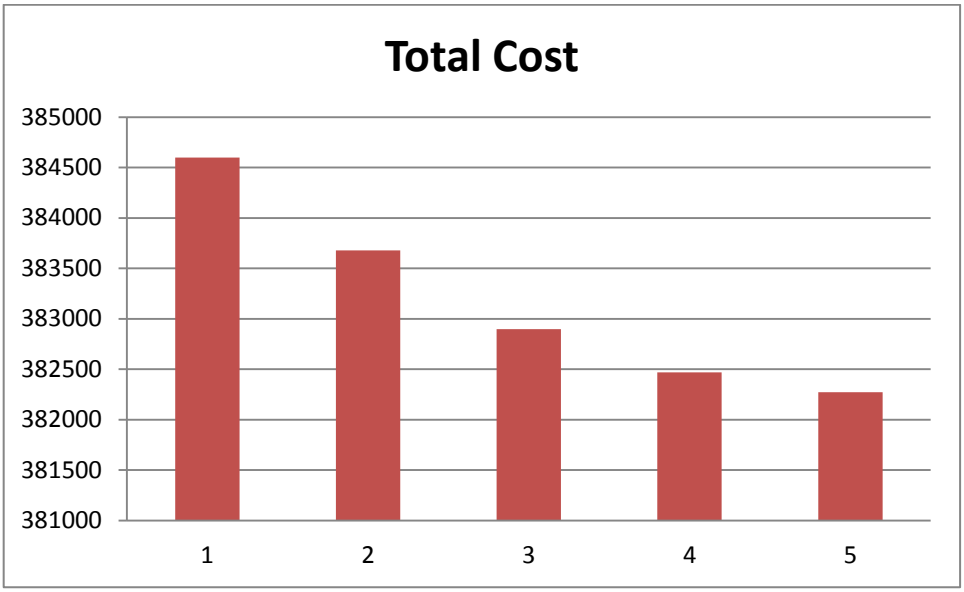
Parameter's values combinations

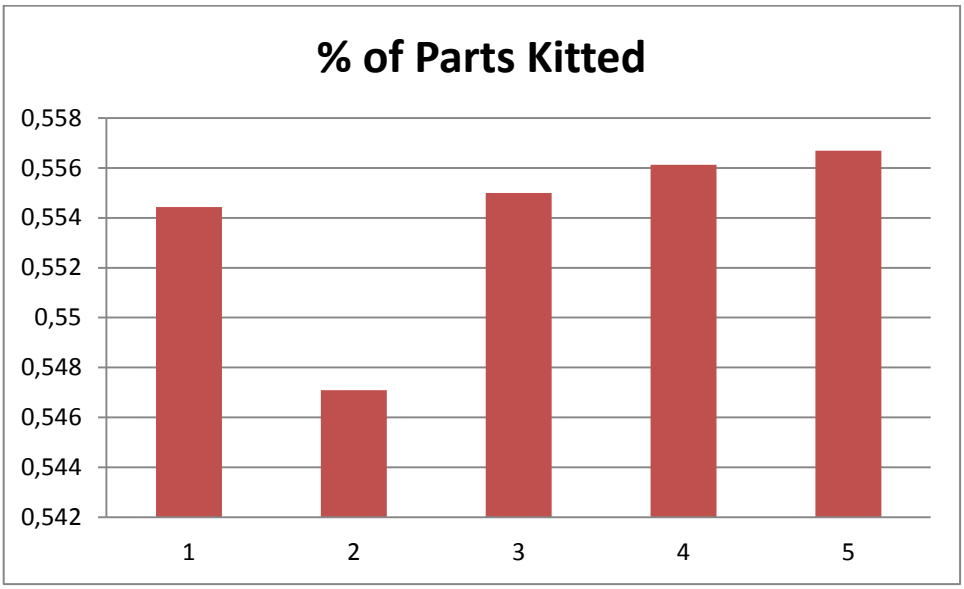
Obtain Combinations

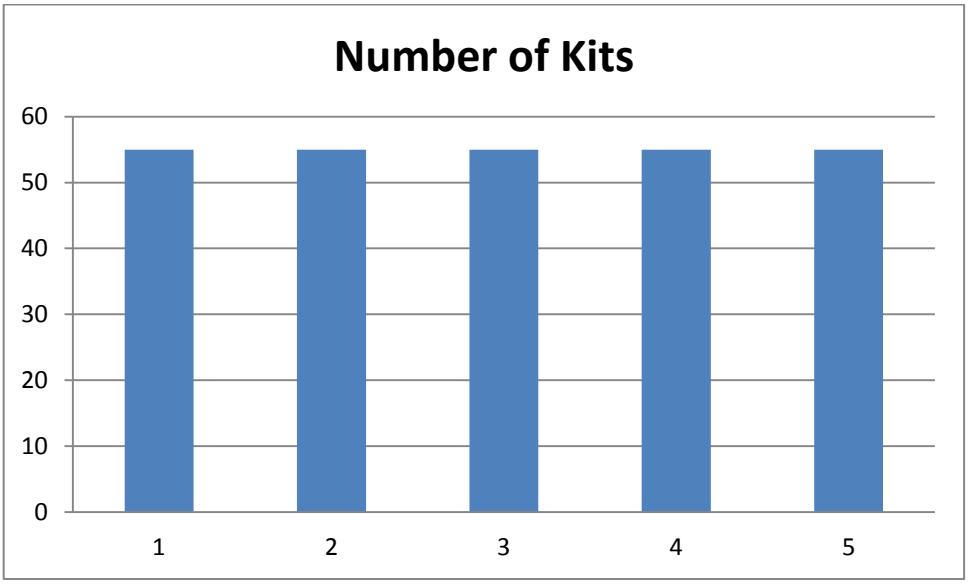
#	OC	OCL	w^k	D^k	D^b	τ^k	τ^{bulk}	B^k	L^{fact}	V^b	V^p	V^k	A^b	A^k	R^b	R^p	V^{fact}	Dp^{fact}	R^{3PL}
Number of result	Operari Cost	Operari Cost Logistic	Maximum weight	Milk Run Tour Kit	Milk Run Tour Box	Search Time Kit	Search Time Bulk	Batch Size	Length Factor	Transport Velocity Box	Transport Velocity Pallet	Transport Velocity Kit	Capacity MRT Box	Capacity MRT Kit	Constant Replenish Box	Constant Replenish Pallet	Volume Factor	Distance Pallet Factor	Constant Replenish 3PL
1	30	30	30	1640	1640	1,08	1,08	1	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
2	30	30	30	1640	1640	1,08	1,08	2	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
3	30	30	30	1640	1640	1,08	1,08	3	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
4	30	30	30	1640	1640	1,08	1,08	4	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
5	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0

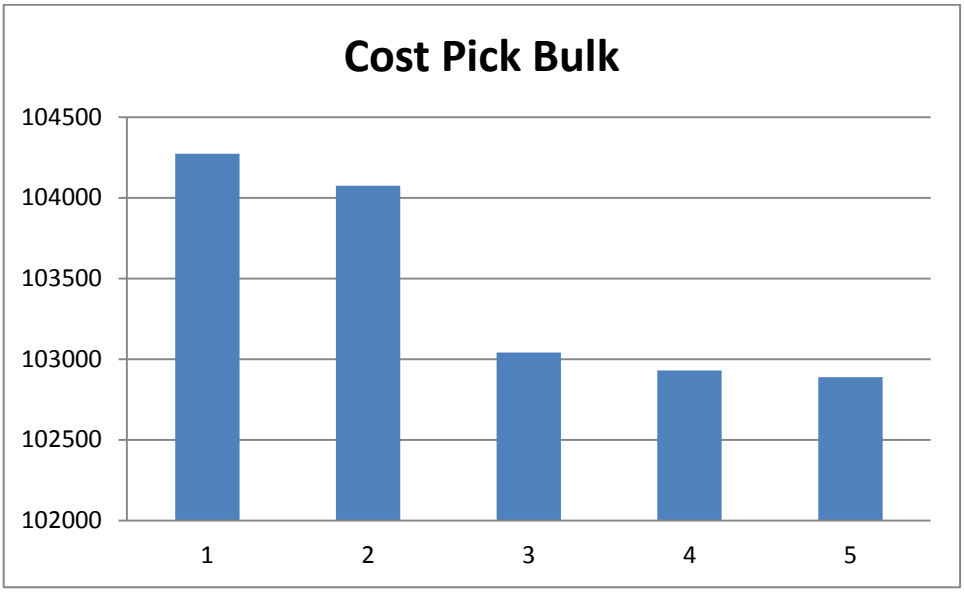
TABLE OF RESULTS

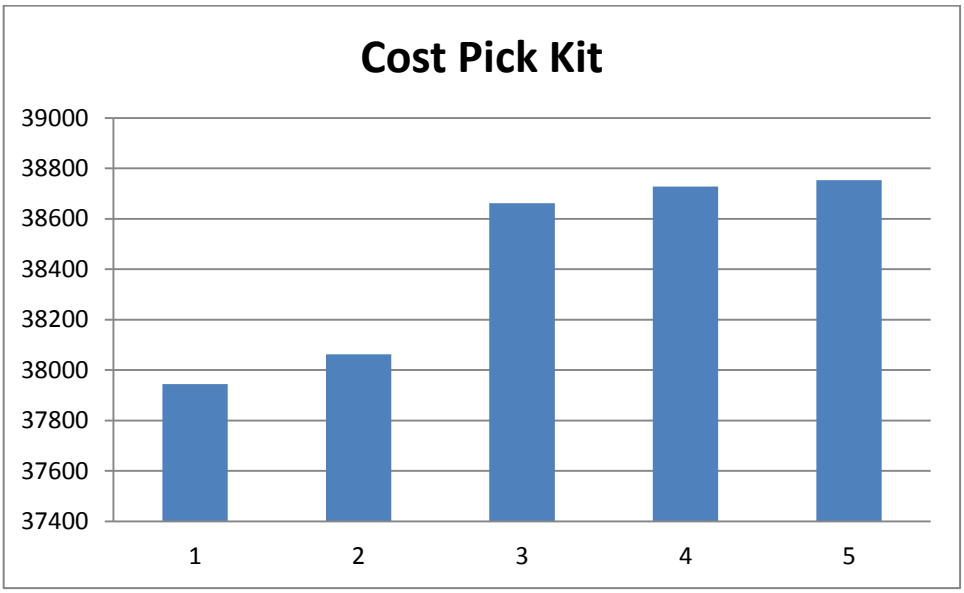
Num.	Num of parts	Total Cost	Cost pick bulk	Cost pick kit	Cost transp pal	Cost transp box	Cost transp kit	Cost of kitting	Cost Repl Pal	Cost Repl box	Cost repl 3PL	Percentage of parts kitted	Number of parts bulked	Number of kits used
Num.	card(COMBI) =	Total_Cost =	Cost_pick_bulk =	Cost_pick_kit =	Cost_Transp_pal =	Cost_Transp_box =	Cost_Transp_kit =	Cost_Kitting =	Cost_Repl_pal =	Cost_Repl_box =	Cost_Repl_3pl =	(sum{(i,s) in COMBI} (1 - x[i,	sum{(i,s) in COMBI} x[i,s] =	sum{s in S} K[s] =
1	1773	384599	104273	37944,4	58488,4	44262,3	70118,2	54705,7	6087,66	8719,45	0	0,554428	790	55
2	1773	383677	104075	38062,5	58488,4	44237,8	70118,2	53881	6087,66	8726,67	0	0,547095	803	55
3	1773	382898	103042	38661,9	58569,4	43968	70118,2	53666,2	6066,66	8806,04	0	0,554992	789	55
4	1773	382470	102931	38727,5	58569,4	44013,4	70118,2	53252,1	6066,66	8792,69	0	0,55612	787	55
5	1773	382271	102889	38753,7	58569,4	44045,8	70118,2	53045,1	6066,66	8783,13	0	0,556684	786	55

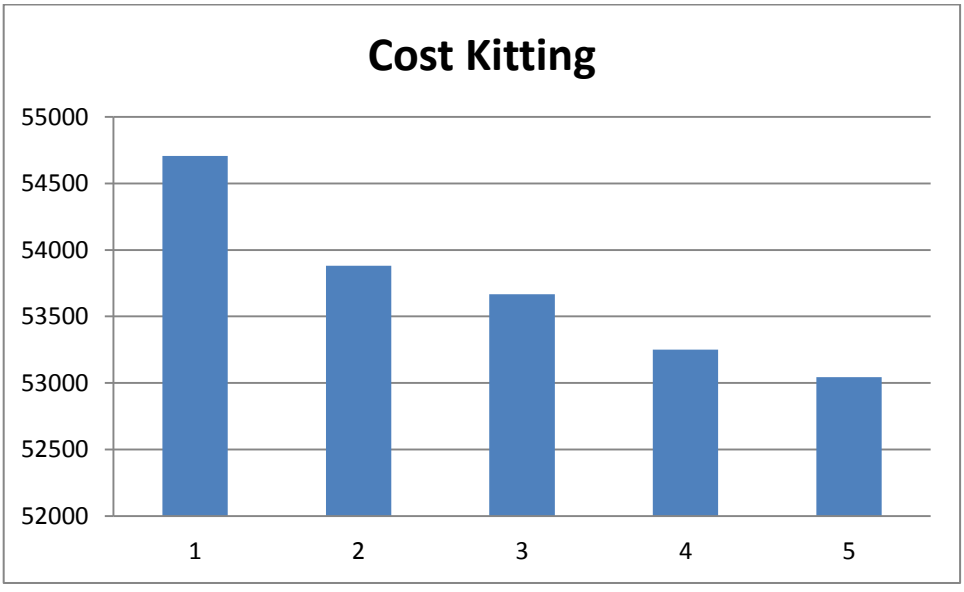

Total Cost
385000
384500
384000
383500
383000
382500
382000
381500
381000
1
2
3
4
5


% of Parts Kitted
0,558
0,556
0,554
0,552
0,55
0,548
0,546
0,544
0,542
1
2
3
4
5


Number of Kits
60
50
40
30
20
10
0
1
2
3
4
5


Cost Pick Bulk
104500
104000
103500
103000
102500
102000
1
2
3
4
5


Cost Pick Kit
39000
38800
38600
38400
38200
38000
37800
37600
37400
1
2
3
4
5


Cost Kitting
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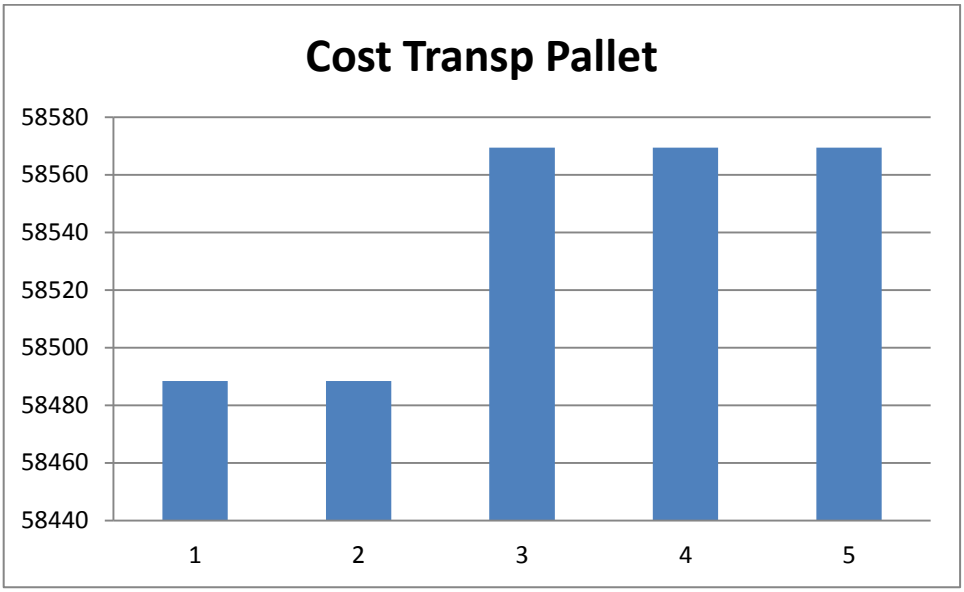
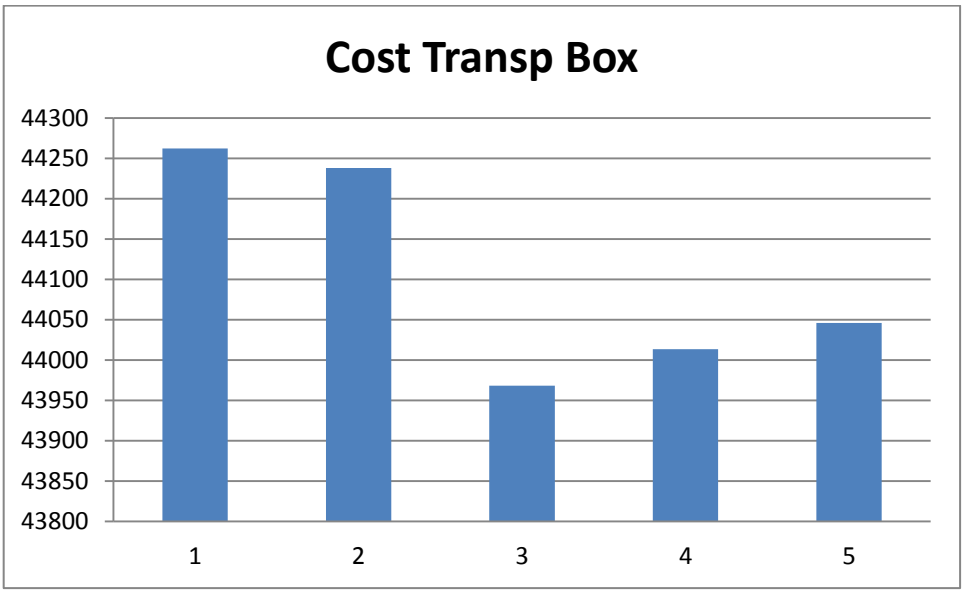
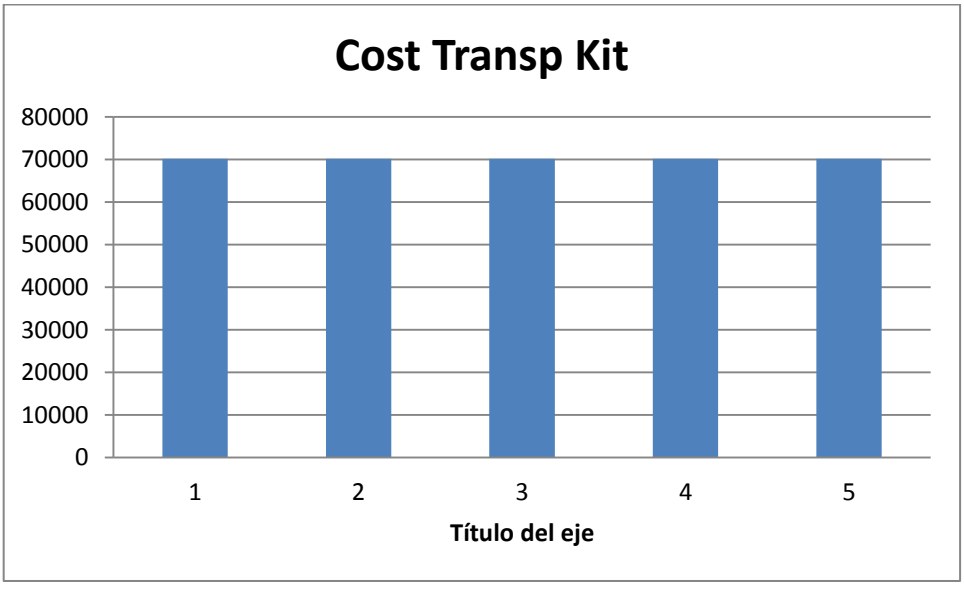
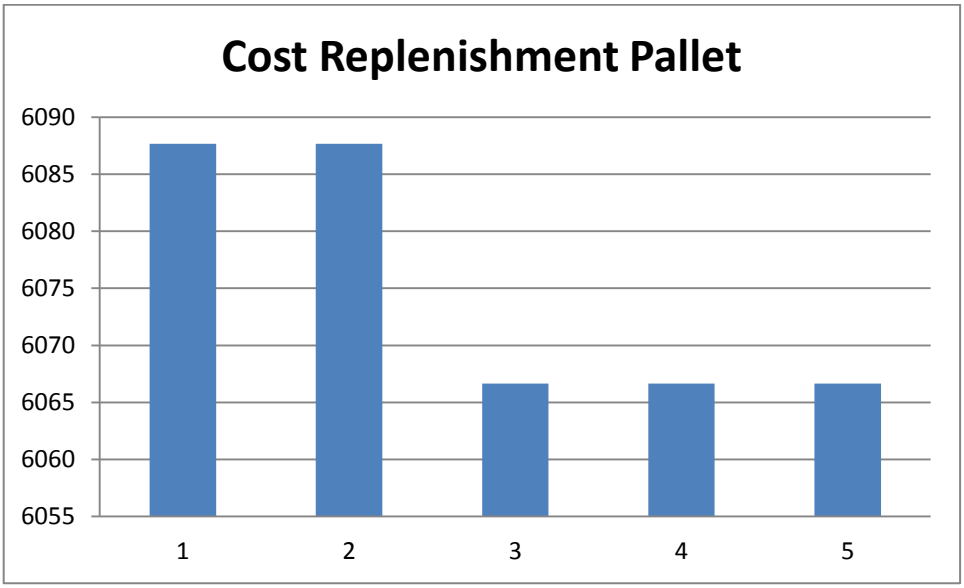
54500
54000
53500
53000
52500
52000
1
2
3
4
5


Cost Transp Pallet
58580
58560
58540
58520
58500
58480
58460
58440
1
2
3
4
5


Cost Transp Box
44300
44250
44200
44150
44100
44050
44000
43950
43900
43850
43800
1
2
3
4
5


Cost Transp Kit
80000
70000
60000
50000
40000
30000
20000
10000
0
1
2
3
4
5
Título del eje


Cost Replenishment Pallet
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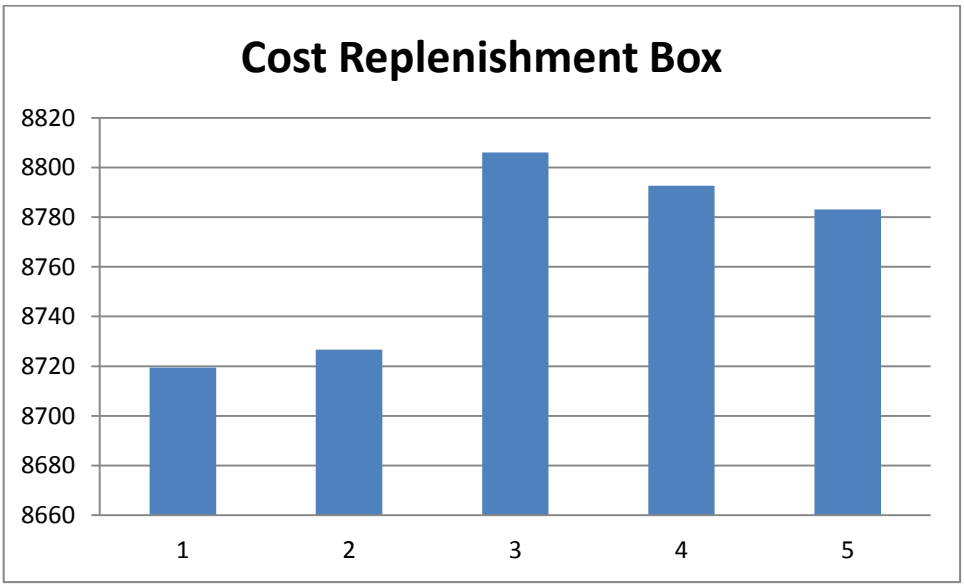
6085
6080
6075
6070
6065
6060
6055
1
2
3
4
5


Cost Replenishment Box
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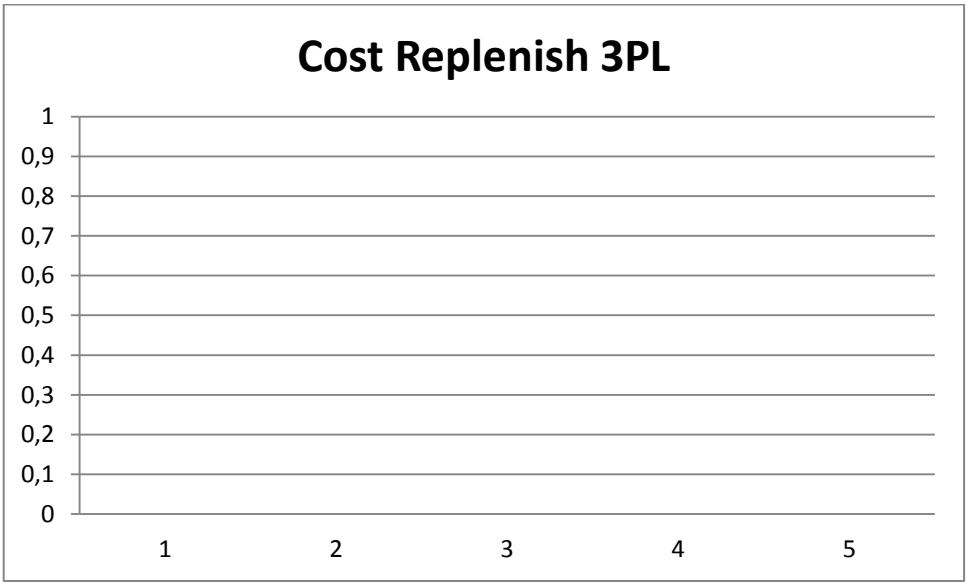
8800
8780
8760
8740
8720
8700
8680
8660
1
2
3
4
5


Cost Replenish 3PL
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
1
2
3
4
5

2.8 Space available at the BoL

TEMPLATE

LOWER VALUE	UPPER VALUE	STEP VALUE	units	# of results	# total results
OPERARI_COST_lower	OPERARI_COST_upper	OPERARI_COST_step			9
30	30	10	€/h	1	
OPERARI_COST_LOGISTIC_lower	OPERARI_COST_LOGISTIC_upper	OPERARI_COST_LOGISTIC_step			
30	30	1	€/h	1	
MAXIMUM_WEIGHT_lower	MAXIMUM_WEIGHT_upper	MAXIMUM_WEIGHT_step			
30	30	2	Kg	1	
MILK_RUN_TOUR_KIT_lower	MILK_RUN_TOUR_KIT_upper	MILK_RUN_TOUR_KIT_step			
1640	1640	100	m	1	
MILK_RUN_TOUR_BOX_lower	MILK_RUN_TOUR_BOX_upper	MILK_RUN_TOUR_BOX_step			
1640	1640	100	m	1	
SEARCH_TIME_KIT_lower	SEARCH_TIME_KIT_upper	SEARCH_TIME_KIT_step			
1,08	1,08	0,01	s	1	
SEARCH_TIME_BULK_lower	SEARCH_TIME_BULK_upper	SEARCH_TIME_BULK_step			
1,08	1,08	0,01	s	1	
BATCH_SIZE_lower	BATCH_SIZE_upper	BATCH_SIZE_step			
5	5	1	kit	1	
LENGTH_FACTOR_lower	LENGTH_FACTOR_upper	LENGTH_FACTOR_step			
1	1,25	0,03125	-	9	
TRANSPORT_VELOCITY_BOX_lower	TRANSPORT_VELOCITY_BOX_upper	TRANSPORT_VELOCITY_BOX_step			
2412	2412	50	m/h	1	
TRANSPORT_VELOCITY_PALLET_lower	TRANSPORT_VELOCITY_PALLET_upper	TRANSPORT_VELOCITY_PALLET_step			
2880	2880	50	m/h	1	
TRANSPORT_VELOCITY_KIT_lower	TRANSPORT_VELOCITY_KIT_upper	TRANSPORT_VELOCITY_KIT_step			
2412	2412	50	m/h	1	
CAPACITY_MRT_BOX_lower	CAPACITY_MRT_BOX_upper	CAPACITY_MRT_BOX_step			
60	60	10	box	1	
CAPACITY_MRT_KIT_lower	CAPACITY_MRT_KIT_upper	CAPACITY_MRT_KIT_step			
70	70	10	kit	1	
CONSTANT_REPLENISH_BOX_lower	CONSTANT_REPLENISH_BOX_upper	CONSTANT_REPLENISH_BOX_step			
0,2	0,2	0,2	€	1	
CONSTANT_REPLENISH_PALLET_lower	CONSTANT_REPLENISH_PALLET_upper	CONSTANT_REPLENISH_PALLET_step			
1,2	1,2	0,6	€	1	
VOLUME_FACTOR_lower	VOLUME_FACTOR_upper	VOLUME_FACTOR_step			
1	1	0,1	-	1	
DISTANCE_PALLET_FACTOR_lower	DISTANCE_PALLET_FACTOR_upper	DISTANCE_PALLET_FACTOR_step			
1	1	0,3	-	1	
CONSTANT_REPLENISH_3PL_lower	CONSTANT_REPLENISH_3PL_upper	CONSTANT_REPLENISH_3PL_step			
0	0	0,1		1	

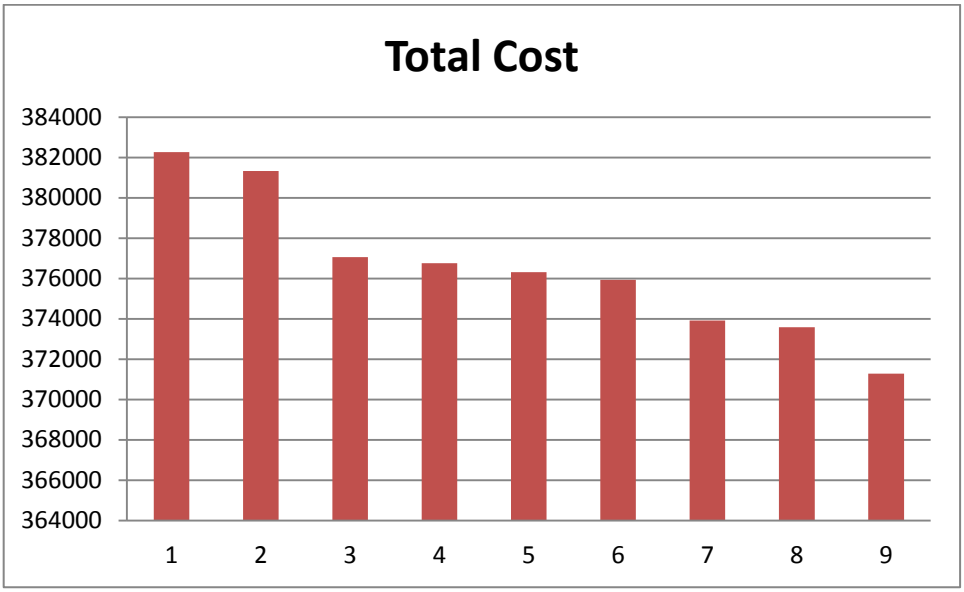
Parameter's values combinations

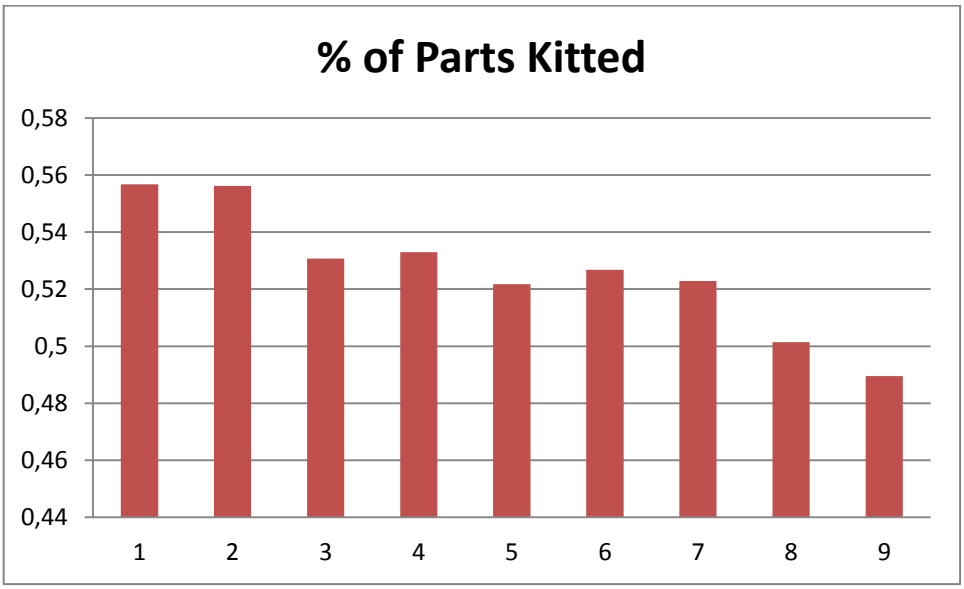
Obtain Combinations

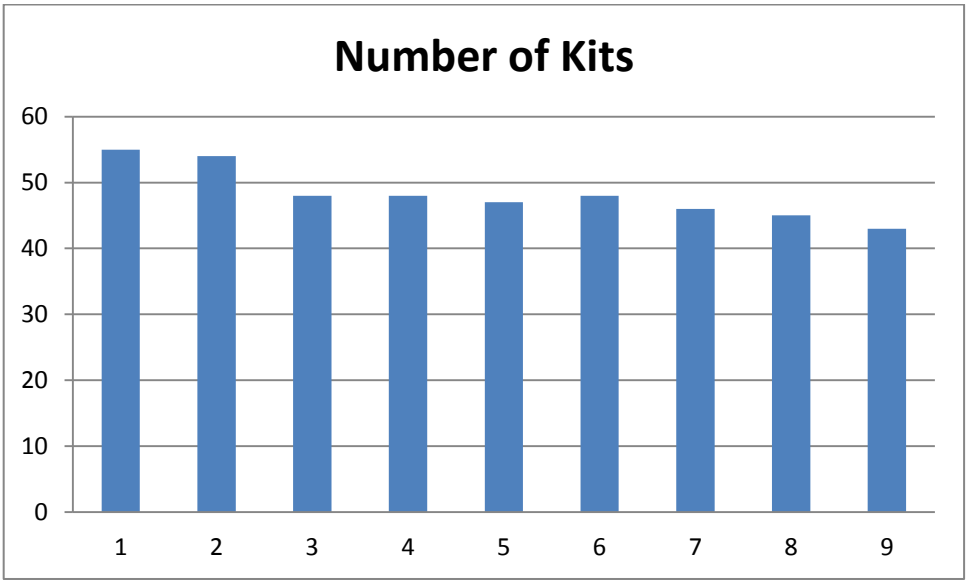
#	OC	OCL	w^k	D^k	D^b	τ^k	τ^{bulk}	B^k	L^{fact}	V^b	V^p	V^k	A^b	A^k	R^b	R^p	V^{fact}	Dp^{fact}	R^{3PL}
Number of result	Operari Cost	Operari Cost Logistic	Maximum weight	Milk Run Tour Kit	Milk Run Tour Box	Search Time Kit	Search Time Bulk	Batch Size	Length Factor	Transport Velocity Box	Transport Velocity Pallet	Transport Velocity Kit	Capacity MRT Box	Capacity MRT Kit	Constant Replenish Box	Constant Replenish Pallet	Volume Factor	Distance Pallet Factor	Constant Replenish 3PL
1	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0
2	30	30	30	1640	1640	1,08	1,08	5	1,03	2412	2880	2412	60	70	0,2	1,2	1	1	0
3	30	30	30	1640	1640	1,08	1,08	5	1,06	2412	2880	2412	60	70	0,2	1,2	1	1	0
4	30	30	30	1640	1640	1,08	1,08	5	1,09	2412	2880	2412	60	70	0,2	1,2	1	1	0
5	30	30	30	1640	1640	1,08	1,08	5	1,13	2412	2880	2412	60	70	0,2	1,2	1	1	0
6	30	30	30	1640	1640	1,08	1,08	5	1,16	2412	2880	2412	60	70	0,2	1,2	1	1	0
7	30	30	30	1640	1640	1,08	1,08	5	1,19	2412	2880	2412	60	70	0,2	1,2	1	1	0
8	30	30	30	1640	1640	1,08	1,08	5	1,22	2412	2880	2412	60	70	0,2	1,2	1	1	0
9	30	30	30	1640	1640	1,08	1,08	5	1,25	2412	2880	2412	60	70	0,2	1,2	1	1	0

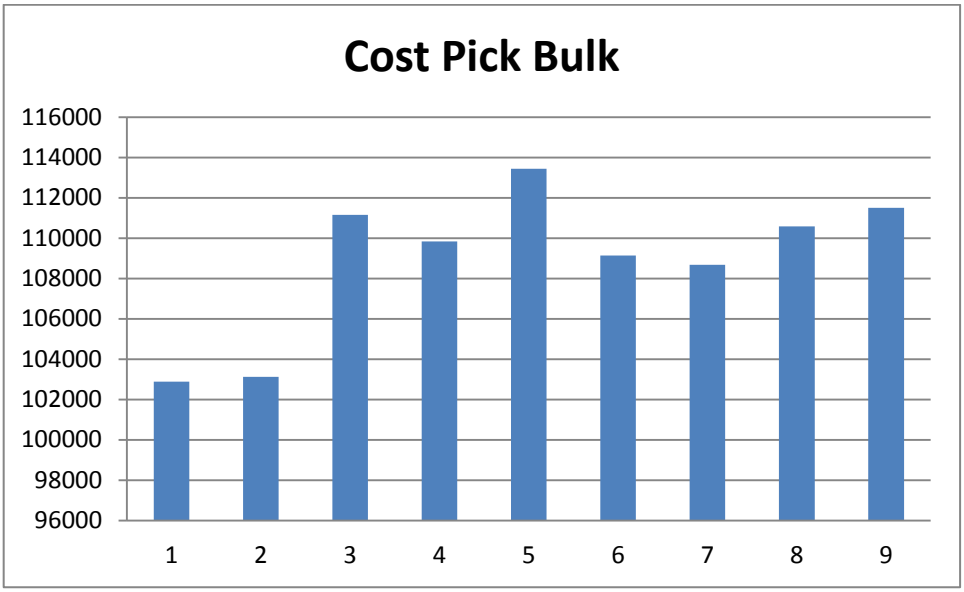
TABLE OF RESULTS

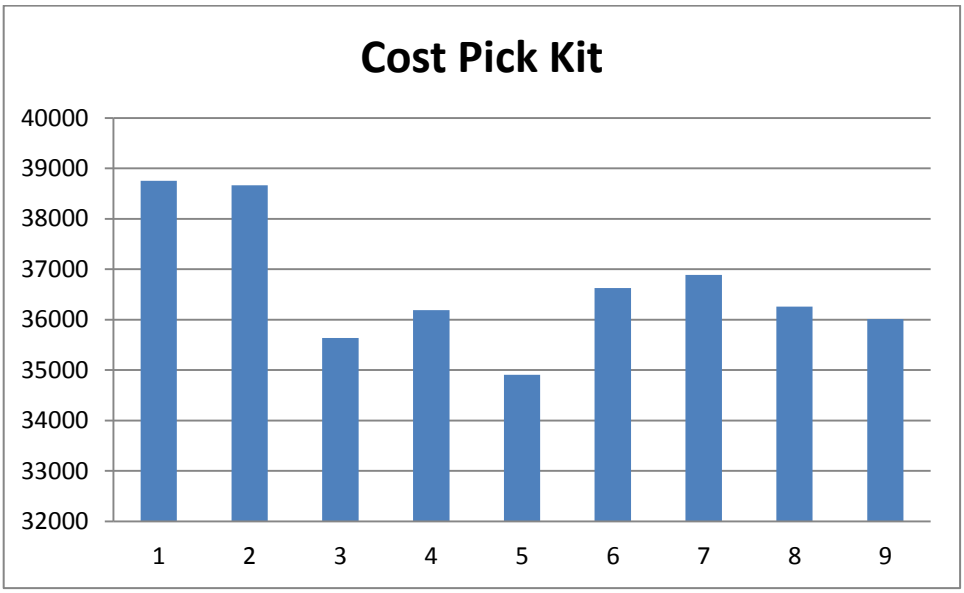
Num.	Num of parts	Total Cost	Cost pick bulk	Cost pick kit	Cost transp pal	Cost transp box	Cost transp kit	Cost of kitting	Cost Repl Pal	Cost Repl box	Cost repl 3PL	Percentage of parts kitted	Number of parts bulked	Number of kits used
Num.	card(COMBI) =	Total_Cost =	Cost_pick_bulk =	Cost_pick_kit =	Cost_Transp_pal =	Cost_Transp_box =	Cost_Transp_kit =	Cost_Kitting =	Cost_Repl_pal =	Cost_Repl_box =	Cost_Repl_3pl =	(sum{(i,s) in COMBI} (1 - x[i,	sum{(i,s) in COMBI} x[i,s] =	sum{s in S} K[s] =
1	1773	382271	102889	38753,7	58569,4	44045,8	70118,2	53045,1	6066,66	8783,13	0	0,556684	786	55
2	1773	381321	103119	38666,2	59303,4	44045,8	68843,3	52634,2	5926,66	8783,13	0	0,55612	787	54
3	1773	377051	111158	35634,4	61717	47349,7	61194	46854,6	5332,08	7811,32	0	0,530739	832	48
4	1773	376763	109834	36185,6	61788,7	46964,6	61194	47574,6	5297,08	7924,58	0	0,532995	828	48
5	1773	376315	113434	34903,7	61002,2	48636,8	59919,2	45539,3	5447,08	7432,72	0	0,521715	848	47
6	1773	375938	109146	36627,5	60545,3	46762,4	61194	48175,5	5503,08	7984,08	0	0,526791	839	48
7	1773	373923	108678	36890	61644,8	47097,5	58644,3	47948,7	5134,09	7885,5	0	0,522843	846	46
8	1773	373589	110588	36260	61726,4	47903,6	57369,4	47008,3	5084,09	7648,39	0	0,50141	884	45
9	1773	371288	111509	36010,6	62528	47758,9	54819,7	46156,7	4814,18	7690,96	0	0,489566	905	43

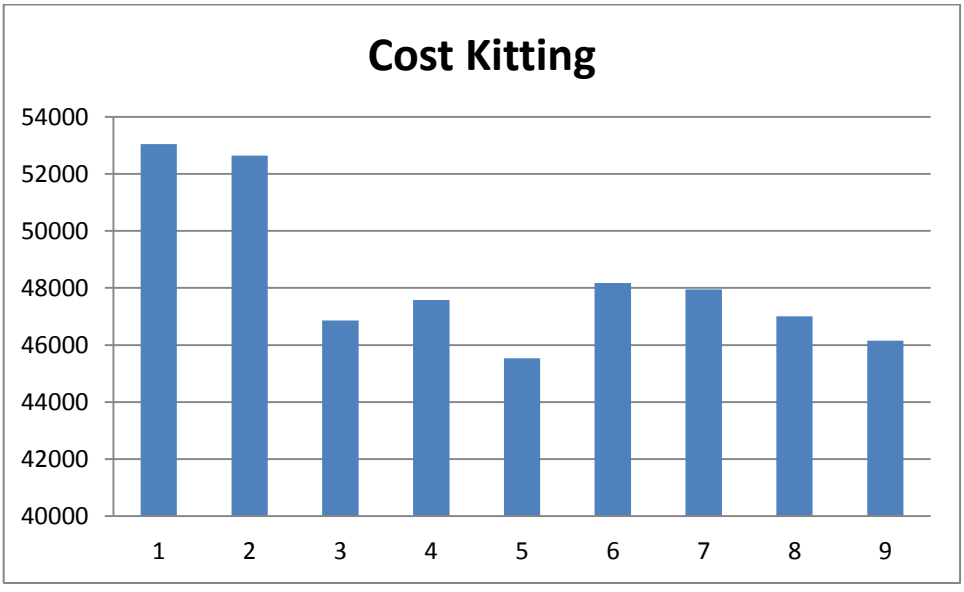

Total Cost
384000
382000
380000
378000
376000
374000
372000
370000
368000
366000
364000
1
2
3
4
5
6
7
8
9

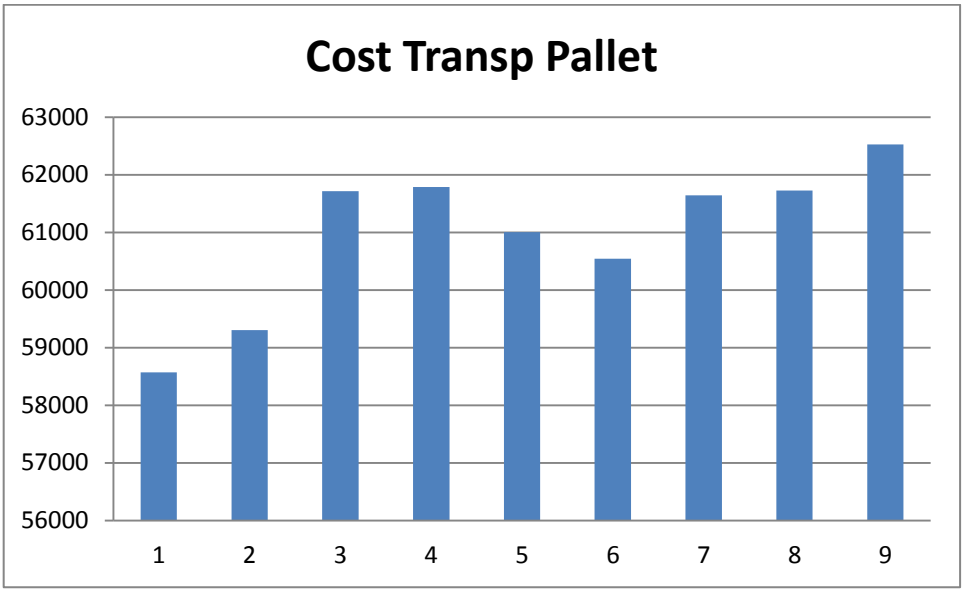

% of Parts Kitted
0,58
0,56
0,54
0,52
0,5
0,48
0,46
0,44
1
2
3
4
5
6
7
8
9

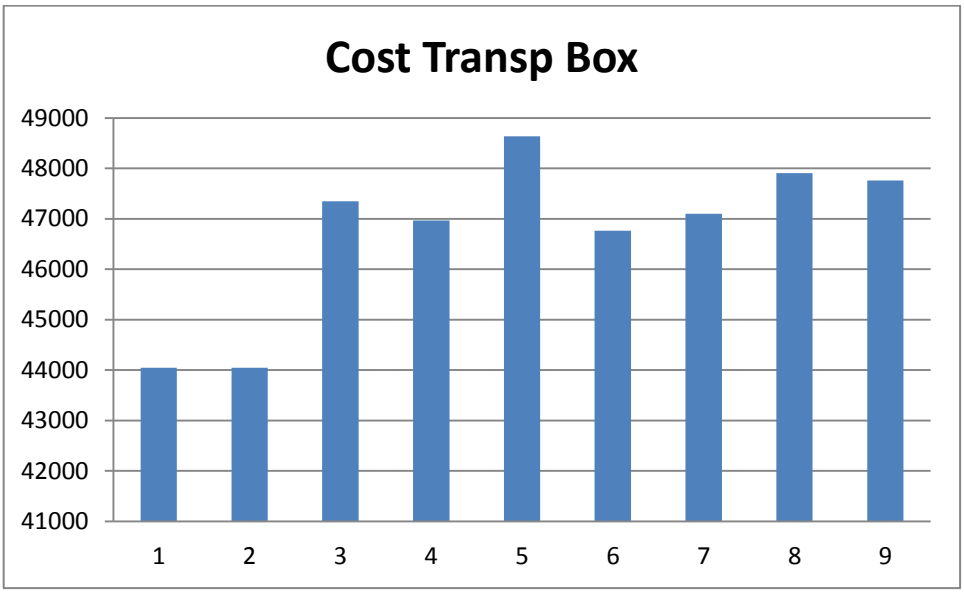

Number of Kits
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9

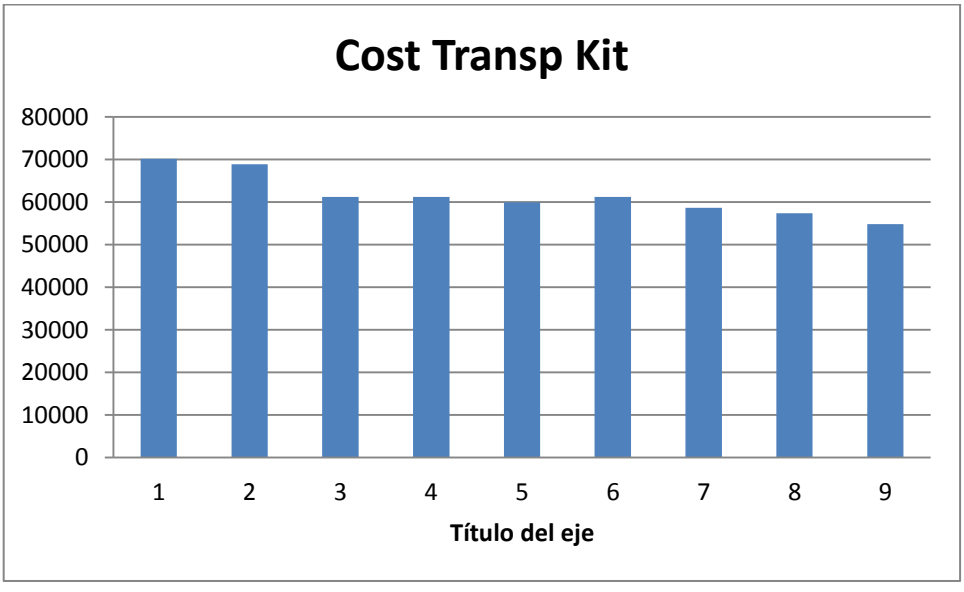

Cost Pick Bulk
116000
114000
112000
110000
108000
106000
104000
102000
100000
98000
96000
1
2
3
4
5
6
7
8
9

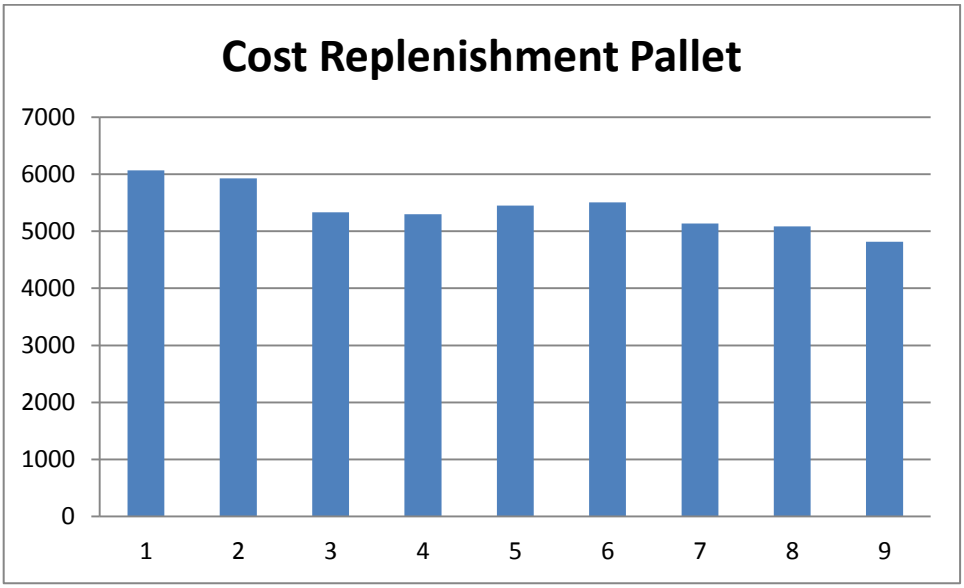

Cost Pick Kit
40000
39000
38000
37000
36000
35000
34000
33000
32000
1
2
3
4
5
6
7
8
9

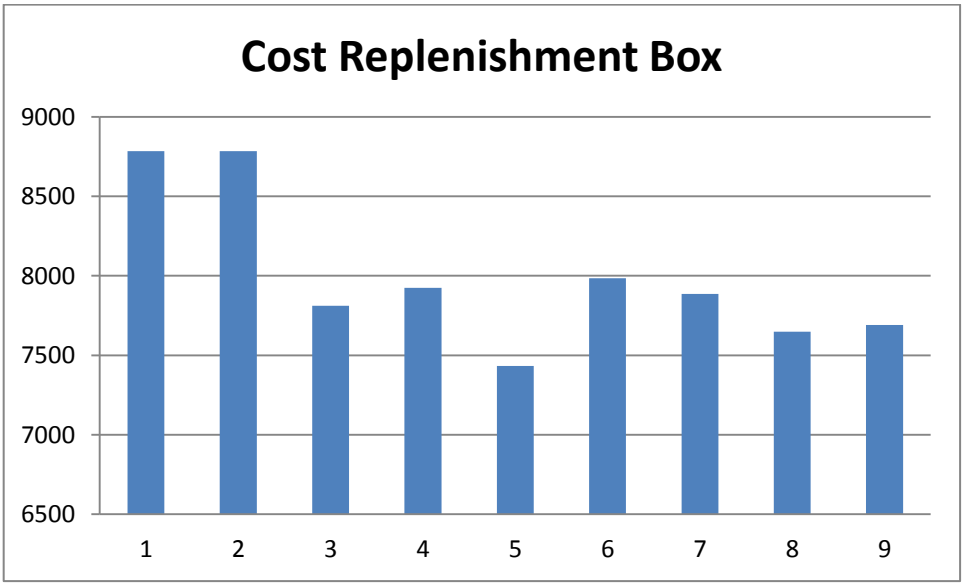

Cost Kitting
54000
52000
50000
48000
46000
44000
42000
40000
1
2
3
4
5
6
7
8
9

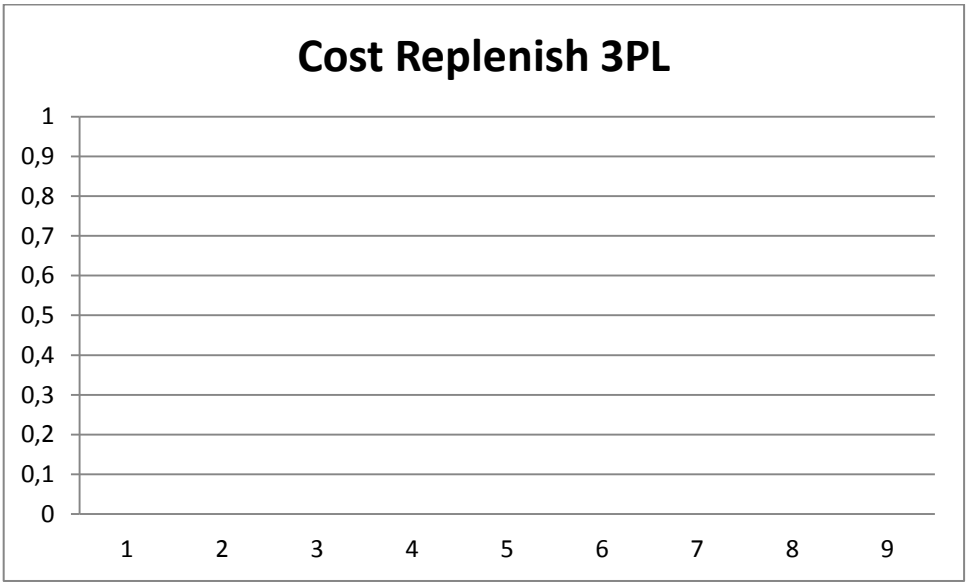

Cost Transp Pallet
63000
62000
61000
60000
59000
58000
57000
56000
1
2
3
4
5
6
7
8
9


Cost Transp Box
49000
48000
47000
46000
45000
44000
43000
42000
41000
1
2
3
4
5
6
7
8
9


Cost Transp Kit
80000
70000
60000
50000
40000
30000
20000
10000
0
1
2
3
4
5
6
7
8
9
Título del eje


Cost Replenishment Pallet
7000
6000
5000
4000
3000
2000
1000
0
1
2
3
4
5
6
7
8
9


Cost Replenishment Box
9000
8500
8000
7500
7000
6500
1
2
3
4
5
6
7
8
9


Cost Replenish 3PL
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
1
2
3
4
5
6
7
8
9

2.9 Total volume of a kit

TEMPLATE

LOWER VALUE	UPPER VALUE	STEP VALUE	units	# of results	# total results
OPERARI_COST_lower	OPERARI_COST_upper	OPERARI_COST_step			6
30	30	10	€/h	1	
OPERARI_COST_LOGISTIC_lower	OPERARI_COST_LOGISTIC_upper	OPERARI_COST_LOGISTIC_step			
30	30	1	€/h	1	
MAXIMUM_WEIGHT_lower	MAXIMUM_WEIGHT_upper	MAXIMUM_WEIGHT_step			
30	30	2	Kg	1	
MILK_RUN_TOUR_KIT_lower	MILK_RUN_TOUR_KIT_upper	MILK_RUN_TOUR_KIT_step			
1640	1640	100	m	1	
MILK_RUN_TOUR_BOX_lower	MILK_RUN_TOUR_BOX_upper	MILK_RUN_TOUR_BOX_step			
1640	1640	100	m	1	
SEARCH_TIME_KIT_lower	SEARCH_TIME_KIT_upper	SEARCH_TIME_KIT_step			
1,08	1,08	0,01	s	1	
SEARCH_TIME_BULK_lower	SEARCH_TIME_BULK_upper	SEARCH_TIME_BULK_step			
1,08	1,08	0,01	s	1	
BATCH_SIZE_lower	BATCH_SIZE_upper	BATCH_SIZE_step			
5	5	1	kit	1	
LENGTH_FACTOR_lower	LENGTH_FACTOR_upper	LENGTH_FACTOR_step			
1	1	0,03125	-	1	
TRANSPORT_VELOCITY_BOX_lower	TRANSPORT_VELOCITY_BOX_upper	TRANSPORT_VELOCITY_BOX_step			
2412	2412	50	m/h	1	
TRANSPORT_VELOCITY_PALLET_lower	TRANSPORT_VELOCITY_PALLET_upper	TRANSPORT_VELOCITY_PALLET_step			
2880	2880	50	m/h	1	
TRANSPORT_VELOCITY_KIT_lower	TRANSPORT_VELOCITY_KIT_upper	TRANSPORT_VELOCITY_KIT_step			
2412	2412	50	m/h	1	
CAPACITY_MRT_BOX_lower	CAPACITY_MRT_BOX_upper	CAPACITY_MRT_BOX_step			
60	60	10	box	1	
CAPACITY_MRT_KIT_lower	CAPACITY_MRT_KIT_upper	CAPACITY_MRT_KIT_step			
70	70	10	kit	1	
CONSTANT_REPLENISH_BOX_lower	CONSTANT_REPLENISH_BOX_upper	CONSTANT_REPLENISH_BOX_step			
0,2	0,2	0,2	€	1	
CONSTANT_REPLENISH_PALLET_lower	CONSTANT_REPLENISH_PALLET_upper	CONSTANT_REPLENISH_PALLET_step			
1,2	1,2	0,6	€	1	
VOLUME_FACTOR_lower	VOLUME_FACTOR_upper	VOLUME_FACTOR_step			
0,5	1	0,1	-	6	
DISTANCE_PALLET_FACTOR_lower	DISTANCE_PALLET_FACTOR_upper	DISTANCE_PALLET_FACTOR_step			
1	1	0,3	-	1	
CONSTANT_REPLENISH_3PL_lower	CONSTANT_REPLENISH_3PL_upper	CONSTANT_REPLENISH_3PL_step			
0	0	0,1		1	

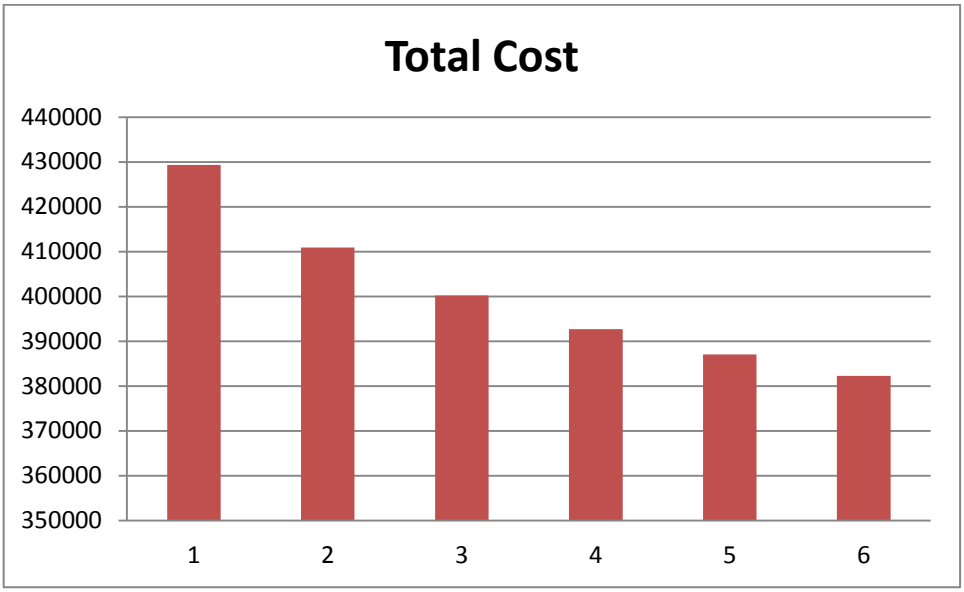
Parameter's values combinations

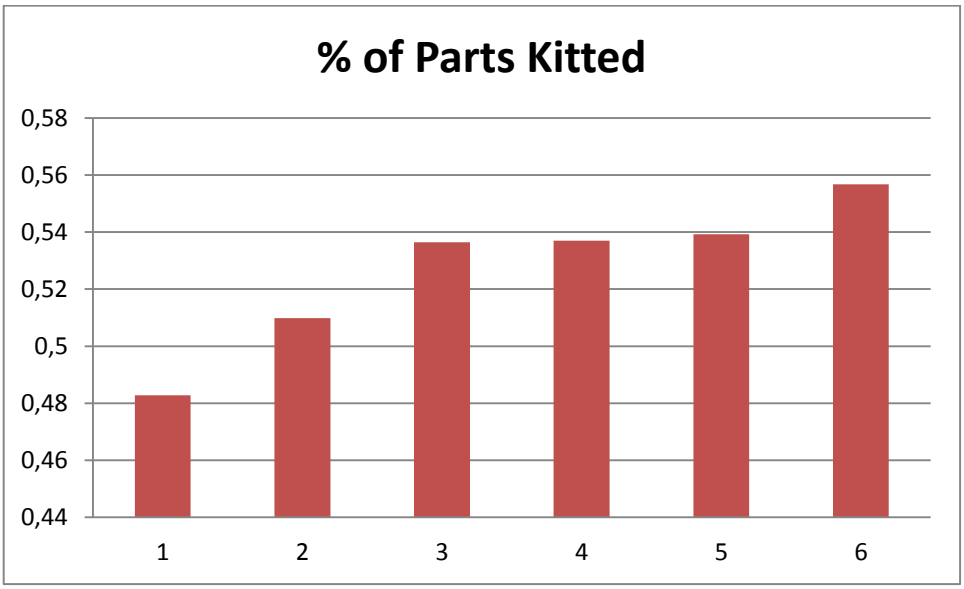
Obtain Combinations

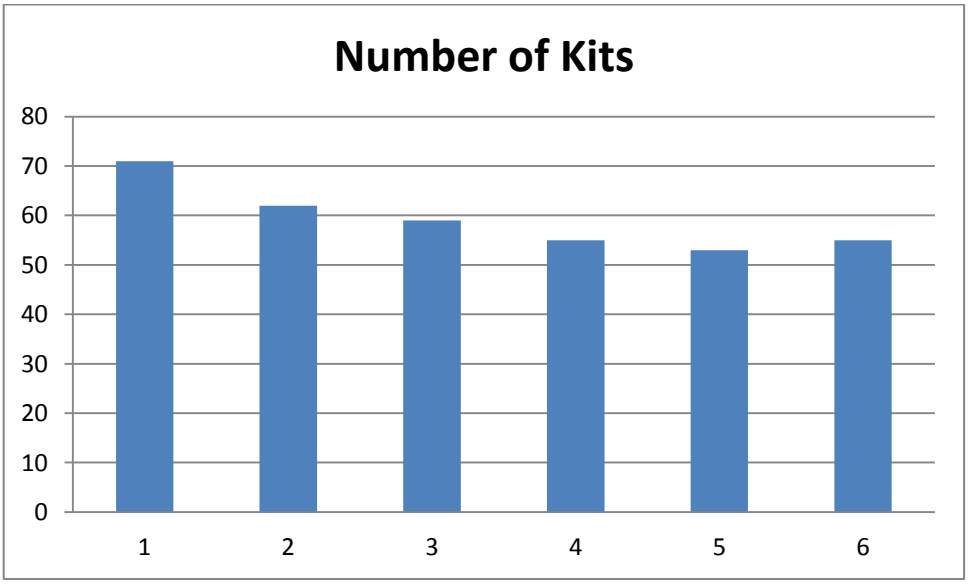
#	OC	OCL	w^k	D^k	D^b	τ^k	τ^{bulk}	B^k	L^{fact}	V^b	V^p	V^k	A^b	A^k	R^b	R^p	V^{fact}	Dp^{fact}	R^{3PL}
Number of result	Operari Cost	Operari Cost Logistic	Maximum weight	Milk Run Tour Kit	Milk Run Tour Box	Search Time Kit	Search Time Bulk	Batch Size	Length Factor	Transport Velocity Box	Transport Velocity Pallet	Transport Velocity Kit	Capacity MRT Box	Capacity MRT Kit	Constant Replenish Box	Constant Replenish Pallet	Volume Factor	Distance Pallet Factor	Constant Replenish 3PL
1	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	0,5	1	0
2	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	0,6	1	0
3	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	0,7	1	0
4	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	0,8	1	0
5	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	0,9	1	0
6	30	30	30	1640	1640	1,08	1,08	5	1	2412	2880	2412	60	70	0,2	1,2	1	1	0

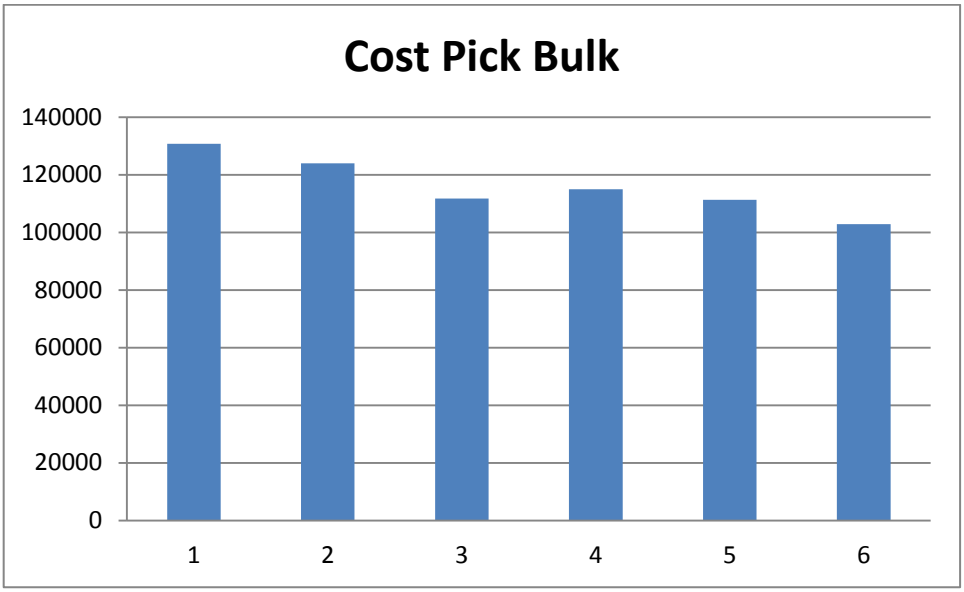
TABLE OF RESULTS

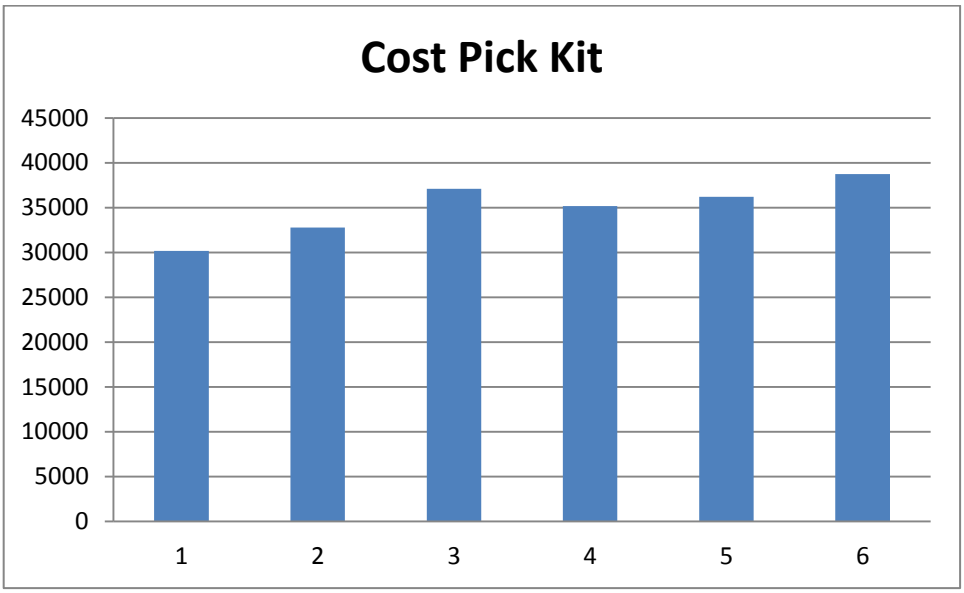
Num.	Num of parts	Total Cost	Cost pick bulk	Cost pick kit	Cost transp pal	Cost transp box	Cost transp kit	Cost of kitting	Cost Repl Pal	Cost Repl box	Cost repl 3PL	Percentage of parts kitted	Number of parts bulked	Number of kits used
Num.	card(COMBI) =	Total_Cost =	Cost_pick_bulk =	Cost_pick_kit =	Cost_Transp_pal =	Cost_Transp_box =	Cost_Transp_kit =	Cost_Kitting =	Cost_Repl_pal =	Cost_Repl_box =	Cost_Repl_3pl =	(sum{(i,s) in COMBI} (1 - x[i,	sum{(i,s) in COMBI} x[i,s] =	sum{s in S} K[s] =
1	1773	429347	130752	30178,7	64078,8	55504,7	90516,2	48614,9	4289,17	5412,54	0	0,482798	917	71
2	1773	410892	123940	32768,7	64218,6	53506,4	79042,3	47076,7	4338,96	6000,34	0	0,50987	869	62
3	1773	400205	111789	37091,2	63452,3	48322,2	75217,7	52320,6	4486,73	7525,25	0	0,536379	822	59
4	1773	392718	114911	35153,1	61874,9	50234,6	70118,2	48490,3	4973,47	6962,75	0	0,536943	821	55
5	1773	387085	111288	36216,2	61236,1	49862,3	67568,4	48564	5277,88	7072,24	0	0,539199	817	53
6	1773	382271	102889	38753,7	58569,4	44045,8	70118,2	53045,1	6066,66	8783,13	0	0,556684	786	55

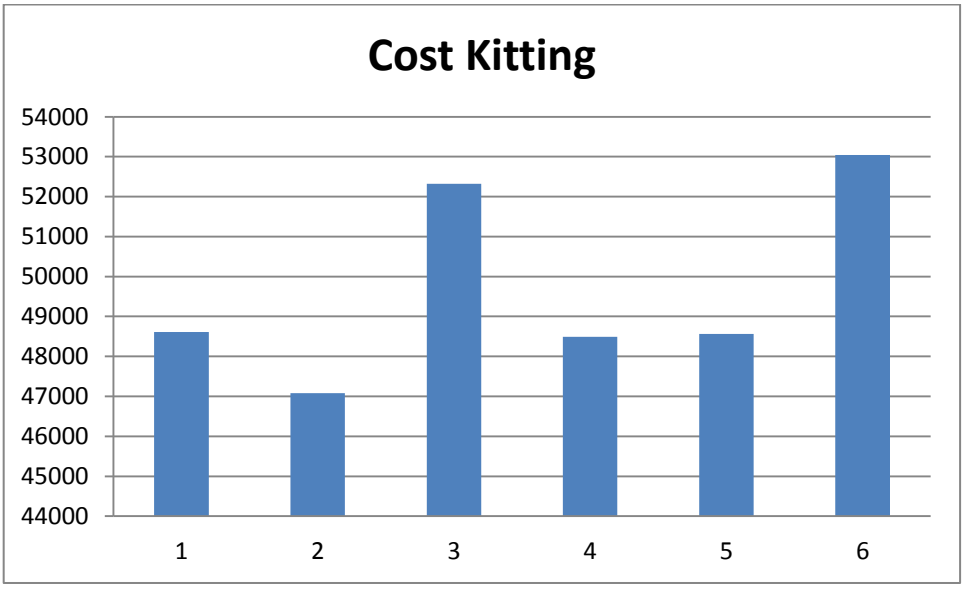

Total Cost
440000
430000
420000
410000
400000
390000
380000
370000
360000
350000
1
2
3
4
5
6


% of Parts Kitted
0,58
0,56
0,54
0,52
0,5
0,48
0,46
0,44
1
2
3
4
5
6


Number of Kits
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6


Cost Pick Bulk
140000
120000
100000
80000
60000
40000
20000
0
1
2
3
4
5
6


Cost Pick Kit
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
1
2
3
4
5
6


Cost Kitting
54000
53000
52000
51000
50000
49000
48000
47000
46000
45000
44000
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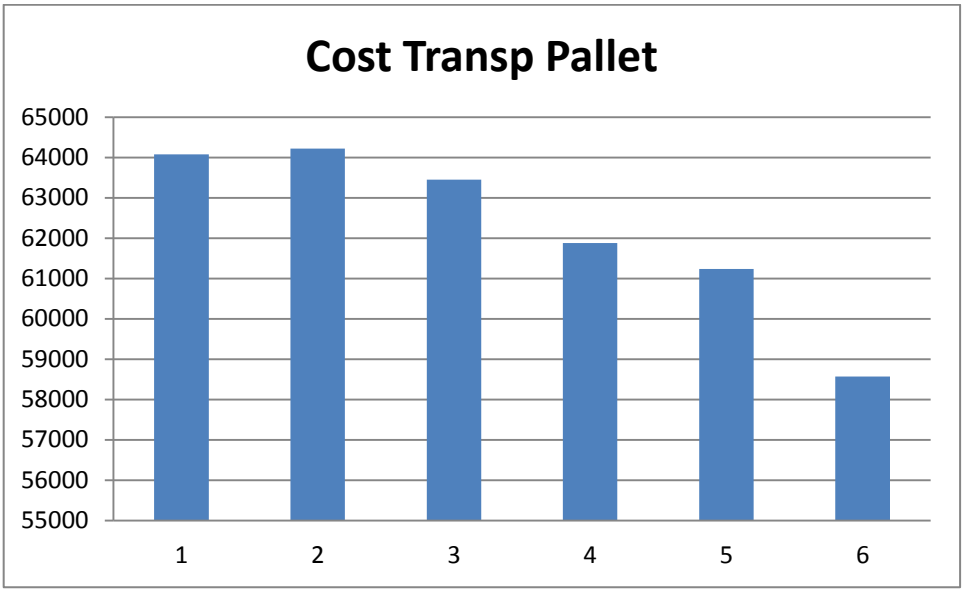
Cost Transp Pallet
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64000
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62000
61000
60000
59000
58000
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55000
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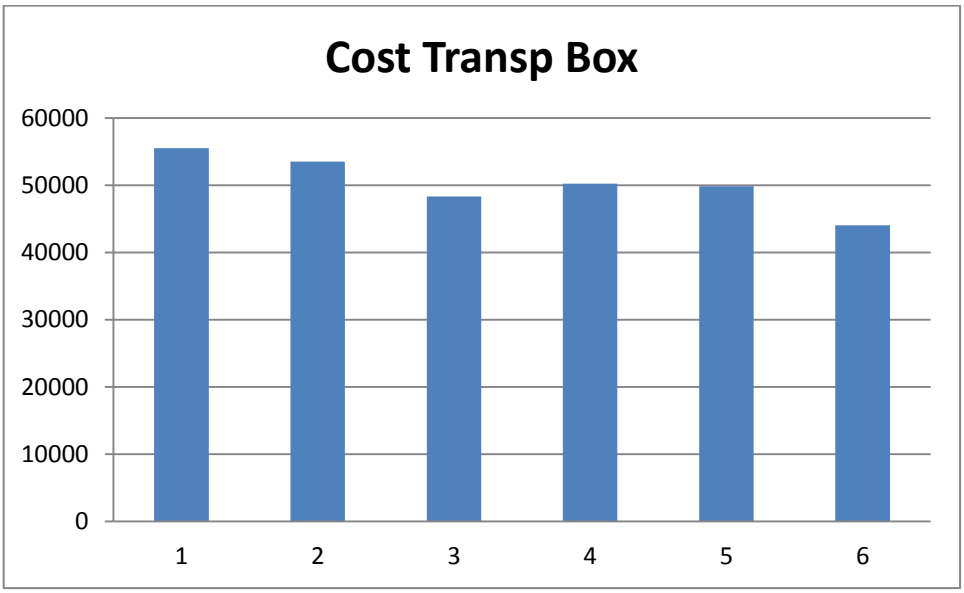
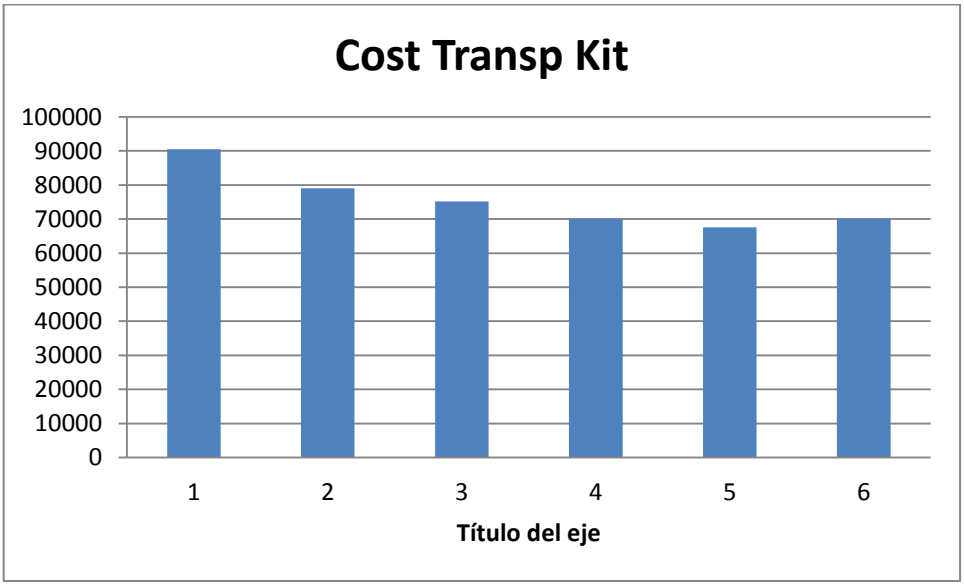
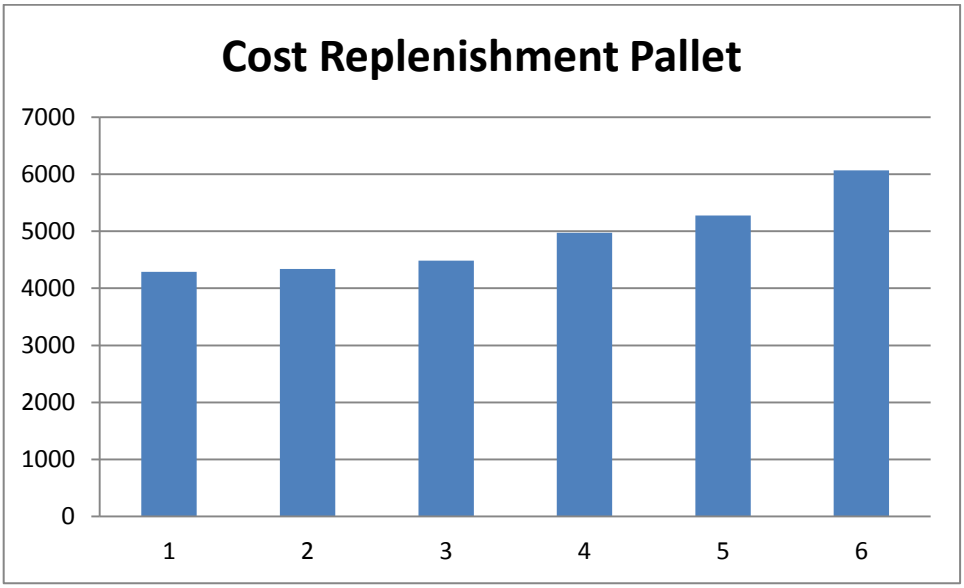
2
3
4
5
6


Cost Transp Box
60000
50000
40000
30000
20000
10000
0
1
2
3
4
5
6


Cost Transp Kit
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
1
2
3
4
5
6
Título del eje


Cost Replenishment Pallet
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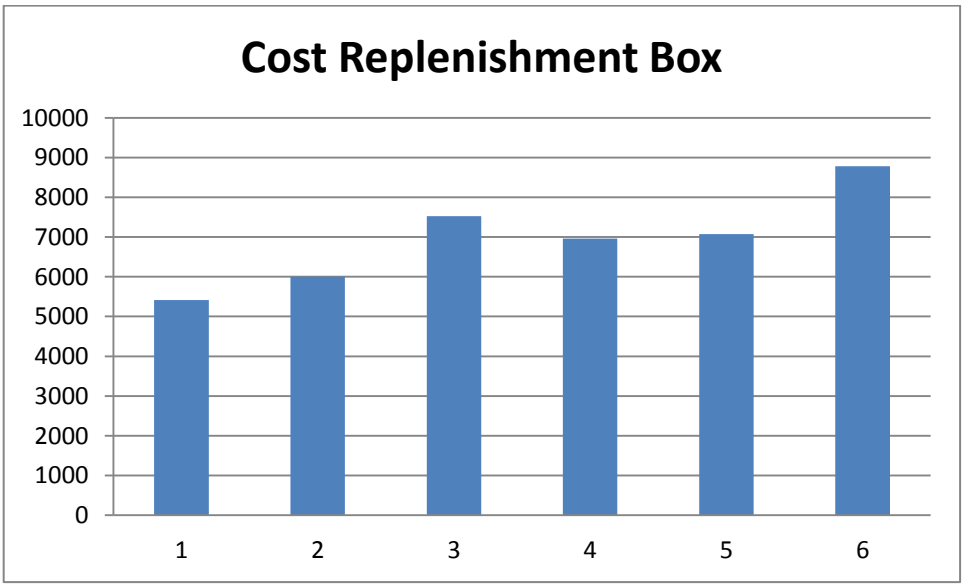
5000
4000
3000
2000
1000
0
1
2
3
4
5
6


Cost Replenishment Box
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8000
7000
6000
5000
4000
3000
2000
1000
0
1
2
3
4
5
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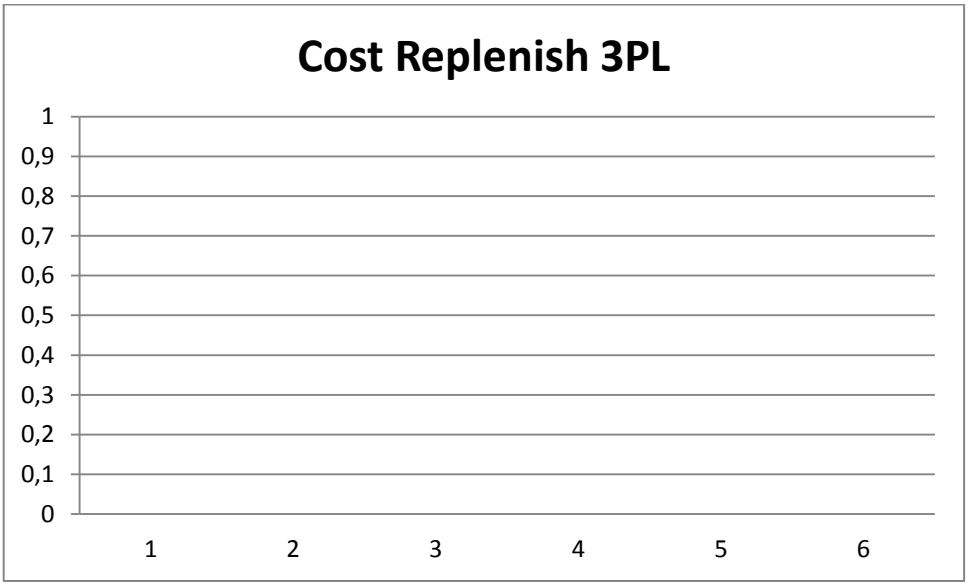
Cost Replenish 3PL
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0,6
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0,4
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0,2
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1
2
3
4
5
6